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# BEIRA, MOZAMBIQUE GATEWAY TO CENTRAL AFRICA[1]

WILLIAM A. HANCE AND IRENE S. VAN DONGEN
*Columbia University*

BEIRA, long the major gateway to the land-locked British territories of the Rhodesias and Nyasaland, was subjected in the first post-war decade to greater pressure than that experienced by any other sub-Saharan port. The unprecedented economic growth in its tributary areas led to severe congestion; its quays and storage facilities were repeatedly clogged with goods, and its feeder rail line, the Beira Railway, was unable to cope with the delivered freight. Ships sometimes lay at anchor 120 days waiting for berth space, and in 1950–51 a 60 percent surcharge was temporarily imposed by the East African Shipping Conference lines on all sea freight booked for Beira. A considerable tonnage destined for the Rhodesias was unloaded at South African ports, requiring a rail haulage almost twice the normal length. An import quota system also had to be applied, administered by the Beira Imports Advisory Committee, still in operation.

International endeavors at the Johannesburg Transport Conference in 1950 to encourage the re-routing of a portion of Northern Rhodesian freight via the *Chemin de Fer du Bas Congo-Katanga* (B.C.K.) to Dilolo and the Benguela Railway to Lobito were largely unsuccessful because of the opposition of Rhodesian and South African transport interests.[2] Efforts were made, therefore, to improve existing facilities at Beira port, and a new 20-year Anglo-Portuguese Convention was signed in 1950 with the object of guaranteeing a steady flow of traffic from British Central Africa through Beira so Mozambique could plan an effective port expansion program.[3] As a measure of relief for the overworked general cargo berths, an E. C. A. loan of $950,000 expedited the construction of a bulk material wharf to handle the shipment of Southern Rhodesian chrome ore.

But it was apparent that additional rail facilities would also be required, and a firm of U. S. engineering consultants was called in to investigate the possibility of double-tracking the Salisbury-Beira section of the existing line and the development of a new rail route from the main Rhodesian trunk to Lourenço Marques, the southernmost port of Mozambique, either via West Nicholson-Beitbridge or via Bannockburn-Guijá.[4] Lourenço Marques, already an outlet for the Transvaal, had the attraction of possessing unused facil-

[1] This article is the fourth in a series of studies prepared under a Columbia University contract with the Office of Naval Research on port terminals serving the central belt of Africa. The first article, "The Port of Lobito and the Benguela Railway," appeared in *The Geographical Review*, October 1956. The authors wish to thank the Office of Naval Research and the many people in the United States and Africa who provided information and assistance.

[2] "Document No. S2," in *Central and Southern Africa Transport Conference, Johannesburg 1950—Final Act and Related Documents* (Johannesburg, The Provisional Organization for Central and Southern African Transport, 1950), pp. 126–131. The outcome of this Conference was reviewed by H. C. Brookfield in "New Railroad and Port Development in East and Central Africa," *Economic Geography*, Vol. 31 (1955), pp. 60–70.

[3] United Kingdom, Treaty Series, *Convention between the Government of the United Kingdom and the Government of the Republic of Portugal, relative to the port of Beira and connected railways, Lisbon, 17th June*, 1950 (Cmd. Paper 8061, London, 1950).

[4] Knappen-Tippets-Abbett Engineering Co. *Alternative Port and Rail Facilities in Mozambique and Southern Rhodesia—A report to the Government of Portugal and the Government of Southern Rhodesia* (mimeographed report, New York, January 1952).

ities. South African ports were considered to lie too far distant from the main Rhodesian productive areas to serve as logical termini and there was strong political feeling against increasing the dependence upon South Africa by effecting any connection through the territory of that country. The recommended route, Bannockburn-Guijá, was constructed in record time, and traffic began moving in August 1955 over the 400-mile line, called the Limpopo Railway or Pafuri Link. It is too early to gauge the future distribution of Central African imports and exports between Beira and Lourenço Marques. Yet a study of the growth and importance of Beira is of interest in its own right and should contribute to an assessment of the suitable outlets for interior Central Africa.

### BEIRA'S DEVELOPMENT AS A GATEWAY

A multiplicity of companies has presided over the birth and growth of the port of Beira and of the two routes penetrating into the interior from the port, one directed to the west and the other to the north. At the end of the nineteenth century the Mozambique Company, involving Portuguese and British interests, received a concession from the Portuguese State to exploit the Portuguese East African region of Manica and Sofala. The British South Africa Company had similar rights in the adjoining territories of Mashonaland and Matabeleland, later combined to form Southern Rhodesia. The opening of the landlocked interior was proceeding slowly along the axis of the High Veld, centering chiefly on Bulawayo and Salisbury. Although the rail line from the Cape had reached Mafeking by 1894, it still took six to seven weeks by ox-wagon to cover the distance of some seven hundred miles from there to Salisbury. It was obvious that a much shorter and quicker route from the interior to the sea lay through the 120-mile wide coastal strip of the neighboring Portuguese territory.

The British South Africa Company, therefore, financed the Beira Railway Company, Ltd., under a concession from the Mozambique Company. Between 1893 and 1896, this new company laid a 0.60-meter gauge line from Ponte de Pungue, 50 miles upstream from Beira on the Pungue River, to the Rhodesian border. Tugs and lighters worked the river stretch to Beira, where elementary provisions for handling cargo were installed at the present site of Chiveve lighterage quay. In 1897, however, the Beira Junction Railway linked Beira and Ponte de Pungue, and in 1899 the rail reached Salisbury. The failure to achieve prior coordination made it immediately necessary to re-lay the track to normal African 3 ft.-6 in. gauge, while the haste and low capital investment involved in the first routing forced considerable realignment.

The Anglo-Boer War broke out in 1899, and the siege of Mafeking soon completely interrupted rail communications south of Bulawayo. All traffic of British Central Africa was perforce diverted to Beira, thus contributing to an early concentration upon that port as the chief outlet of the Rhodesias. The present pattern of the Rhodesian rail system was achieved by the First World War.[5]

By 1915 the port traffic of Beira had built up to 200,000 tons, and in 1929, soon after the Rhodesias passed to the British Crown, it reached about one million tons. A succession of management companies was created in the 1920's, of which the Beira Works, Ltd., with an original capital of £600,000, operated the port from 1926 to 1948–49. Some dredging of the harbor was carried out and mooring buoys were provided. The first deepwater berth was opened in 1929, but its flimsy construction caused ship masters to avoid it for some time. Also in 1929, a new private company, the Rhodesia Railways, Ltd., took over the existing Rhodesian lines, while a subsidiary, Beira Railways, assumed charge of the section from Umtali to Beira, the two operating under a Railway Commission.

Beira's berths 2 and 3 at the present deepwater wharf were completed in 1932, tying in with the existing lighterage facilities at Chiveve quay. In 1937–38, berths 4 and 5 were added, following a press campaign in the Rhodesias against Beira Works's apparent neglect of the port. Further harbor improvement by the British company was cut short by the war and later by the prospect of Portuguese nationalization.

The route from the north to Beira was begun in 1907 with construction of the Shire High-

[5] A vivid personal account of railroad building in the central belt of Africa may be found in H. F. Varian, *Some African Milestones* (Oxford, 1953). See also, for Beira: Mozambique, Administração dos Portos Caminhos de Ferro, e Transportes, *Porto e Caminho de Ferro da Beira* (Lourenço Marques, 1952).

lands Railway linking Blantyre with Port Herald in Nyasaland. This section, measuring 273 miles, together with a later northern extension from Blantyre to Salima, now belongs to the Nyasaland Railways Co. (N.R.). In 1913–15, a subsidiary company, the Central African Railway Co. C.A.), brought the Nyasaland track 43 miles from Port Herald to the northern bank of the Zambezi River which was navigable to Chinde, a small port at the river's mouth. For a while the Portuguese considered drawing Nyasaland's traffic toward another coastal point, Quelimane, from which a railroad was being built. However, construction of a 181-mile rail line in 1919–22 from Dondo on the Beira-Umtali trunk to the southern bank of the Zambezi about 25 miles downstream from the terminus on the north bank drew Nyasaland traffic toward Beira. This line, known as the Trans-Zambesia Railway Co., Ltd. (T.Z.R.), is also affiliated with Nyasaland Railways. In 1935, a bridge across the Zambezi, constructed with financial assistance from the Nyasaland government, permitted linking the various sections of the northern route. Finally, in 1939–49, a Mozambique rail administration branch, the Tete Railway (C.F.T.), was built to serve the Moatize coal fields,[6] 155 miles from Dona Ana.

With the expiration of the Mozambique Company's concession in 1942, the Portuguese government undertook to reorganize the administration and economy of the area centered on Beira. The Portuguese Overseas Ministry bought the facilities of the port itself in 1948 for £2 million and the Ministry of Finance bought the Beira Railway in 1949 for £4 million, the operation of both being assigned to the Mozambique Ports, Railways and Transports Administration (C.F.M.) with headquarters in Lourenço Marques.[7] In the meantime, in 1947 the lines in Northern and Southern Rhodesia became the state-owned Rhodesia Railways, Ltd. (R.R.), but the Nyasaland rail system has continued to be privately operated, partly because it is entirely separate physically from the Rhodesian system, partly because it would not have been appropriate for an alien state to operate the subsidiary T.Z.R. in Portuguese territory.

These administrative changes occurring in the late forties and the later establishment of the Central African Federation had no immediate effect upon the status of Beira as the primary gateway for seaborne commerce moving to and from the Rhodesias and Nyasaland.

[6] In addition to these lines there is a 56-mile, 0.60-meter gauge private line of the Sena Sugar Estates, Ltd., running between Caia and Marromeu.

[7] This distinction in ownership results in a different financial setup for the two transport entities. While the port of Beira is expected, upon repayment of the purchase price, to become an integral property of C.F.M., no provision for transfer was made for the Beira Railway.

TABLE 1.—BEIRA PORT TRAFFIC, 1938, 1948, 1954[1]
Goods in short or harbor tons (2,000 lbs.)

| Type of traffic | 1938 | 1948 | 1954 |
|---|---|---|---|
| *Goods Traffic* | *1,201,100* | *1,586,478* | *2,906,918*[2] |
| Imports | 500,200 | 860,744 | 1,447,844 |
| Exports | 700,900 | 725,734 | 1,459,074 |
| *Passenger Traffic* (Embarked and disembarked) | 12,076 | 17,212 | 29,907 |
| *Shipping Traffic* | | | |
| Number of ships entering | 710 | 542 | 879[3] |
| Gross registered tonnage | 4,198,602 | 2,948,158 | 6,276,169 |
| Net registered tonnage | n.a. | 1,745,673 | 3,656,156 |
| *Bunkerage Trade* | — | — | —[4] |

[1] Sources: *1938:* Mozambique, Repartição Técnica de Estatística, *Anuário Estatístico 1938* (Lourenço Marques, 1940), p. 338. *1948*: Mozambique, C. F. M., *Relatório do Ano Económico 1948* (Lourenço Marques, 1950), pp. 290–294; Repartição Técnica de Estatística, *Estatística do Comércio Externo e da Navegação 1948,* p. 227 (for shipping traffic.) *1954*: C. F. M. administration records; *Anuário Estatístico 1954,* p. 385 (for shipping traffic).
[2] Of which about 116,000 tons in coastal trade.
[3] Of which 171 units in coastal trade (GRT—309,728; NRT—169,065).
[4] Regular bunkerage facilities became available only in April 1955.

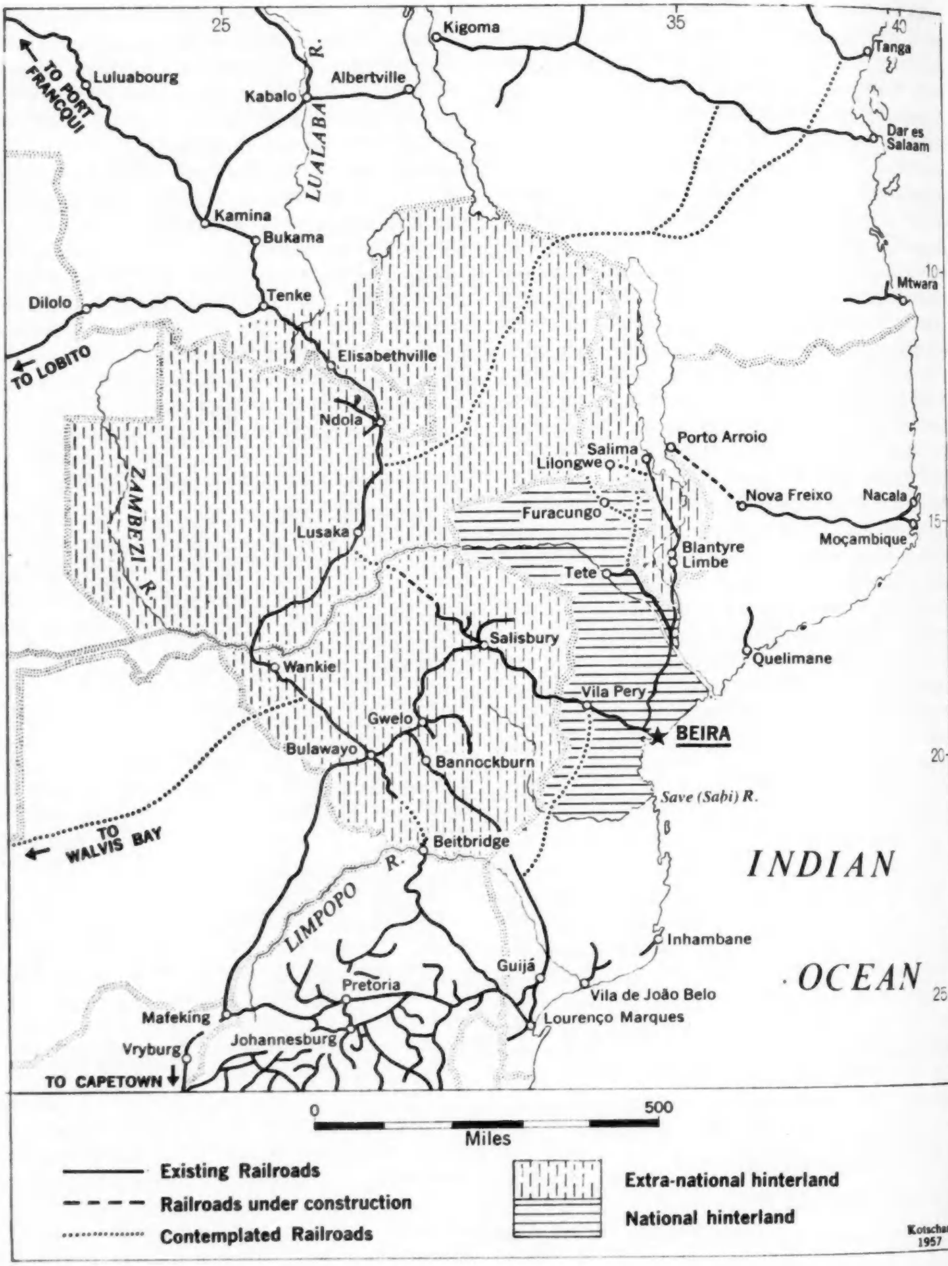


FIG. 1. Beira and its central African hinterland.

The dependence of the latter on the port continued to increase with accelerated mineral and agricultural activity. The southeastern portion of the Belgian Katanga, too, has regularly used Beira for a moderate volume of mineral exports. Under Portuguese management, total volume of port trade (domestic and transit) doubled from 1948 to 1954 (Table 1), and Beira Railway haulings passed from 1,523,615 to 2,748,494 metric tons. Shipping traffic, which showed signs of slackening in 1948, also rose considerably from the prewar levels. The resultant port and rail earnings have been making an increasingly significant contribution to Mozambique's traditionally deficit commercial balance of payments.

Until the Limpopo Railway was opened in August 1955, Beira stood as a major world gateway to some 585,000 square miles of national and extra-national hinterland, an area almost one-fifth the size of the United States (Fig. 1). Produce handled over Beira's wharves covered a wide range of commodities (Table 2). On the sea side it was a magnet for maritime routes, several of which terminated at Beira because of its geographical location at equal distance (about 7,650 nautical miles) from European North Atlantic ports via the Suez Canal or the Cape of Good Hope. Maritime cargo rates of shipping conference lines also showed a decided preference for Beira in comparison with other ports serving central Africa.[8]

TABLE 2.—COMMODITY TRAFFIC AT BEIRA, 1954[1]
In short or harbor tons (2,000 lbs.)

| Commodity | Tons | Percent of total |
|---|---|---|
| *Cargo embarked* | | |
| Copper | 509,232 | 34.9 |
| Chrome ore | 356,888 | 24.5 |
| Unmanufactured tobacco | 198,599 | 13.6 |
| Asbestos | 82,197 | 5.6 |
| Zinc | 25,536 | 1.8 |
| Sugar | 22,933 | 1.6 |
| Cotton fiber | 19,214 | 1.3 |
| Maize | 17,389 | 1.2 |
| Tea | 16,548 | 1.1 |
| Timber | 14,937 | 1.0 |
| Liquid fuels | 14,832 | 1.0 |
| Hides and skins | 6,730 | 0.5 |
| Sisal | 3,133 | 0.2 |
| Coal | 942 | 0.1 |
| Other | 169,964 | 11.6 |
| | 1,459,074 | 100.0 |
| *Cargo disembarked* | | |
| Petroleum products | 480,008 | 33.2 |
| Timber | 124,643 | 8.6 |
| Railroad equipment | 86,429 | 6.0 |
| Fertilizers | 70,995 | 4.9 |
| Construction materials | 66,247 | 4.6 |
| Wheat | 62,042 | 4.3 |
| Motor vehicles | 55,293 | 3.8 |
| Coal | 40,612 | 2.8 |
| Cement | 38,399 | 2.7 |
| Textiles | 32,778 | 2.3 |
| Sugar | 25,837 | 1.8 |
| Road surfacing materials | 22,953 | 1.6 |
| Packaging materials | 14,198 | 1.0 |
| Wines and alcoholic bev. | 16,273 | 1.1 |
| Salt | 14,181 | 1.0 |
| Other | 296,956 | 20.3 |
| | 1,447,844 | 100.0 |

[1] National and extra-national overseas trade and domestic coastal trade. Source: C.F.M. administration records.

THE PORT AND CITY

It is notable that Beira has achieved such prominence as a seaport despite a mediocre physical site. Located at the confluence of Pungue and Buzi rivers, fifteen miles inside Pungue's mouth, the port terminal and the oldest part of the city spread on the northeastern shore over a low, unstable flatland of marsh and silt fringed with mangrove swamps. Along the ocean front the coast stretches for miles in a long, sandy beach. The coastal waters are everywhere shallow and the 5-fathom line lies far away from the shoreline (Fig. 2, lower). Sand banks abound at Pungue's mouth, and access to the inner harbor is controlled by the changing water depths over the entrance bar.

The restricted depths at low tide (11 to 12 feet) in the Portela navigation channel and the strong currents that sometimes surge in the estuary have made pilotage into Beira compulsory. But the high tidal range of 18–23 feet allows entry by all ocean going vessels drawing up to 30 feet. Deepening of the channel would be desirable and maintenance dredging should be carried out regularly in the harbor, for Pungue River brings down large quantities of

[8] Comparative cargo rates for Beira, Lobito, and Port Elizabeth in 1951–52 are given by José d'Almada in *A Historical Outline of the Benguela Railway, 1902–1952* (London, 1954), p. 61.

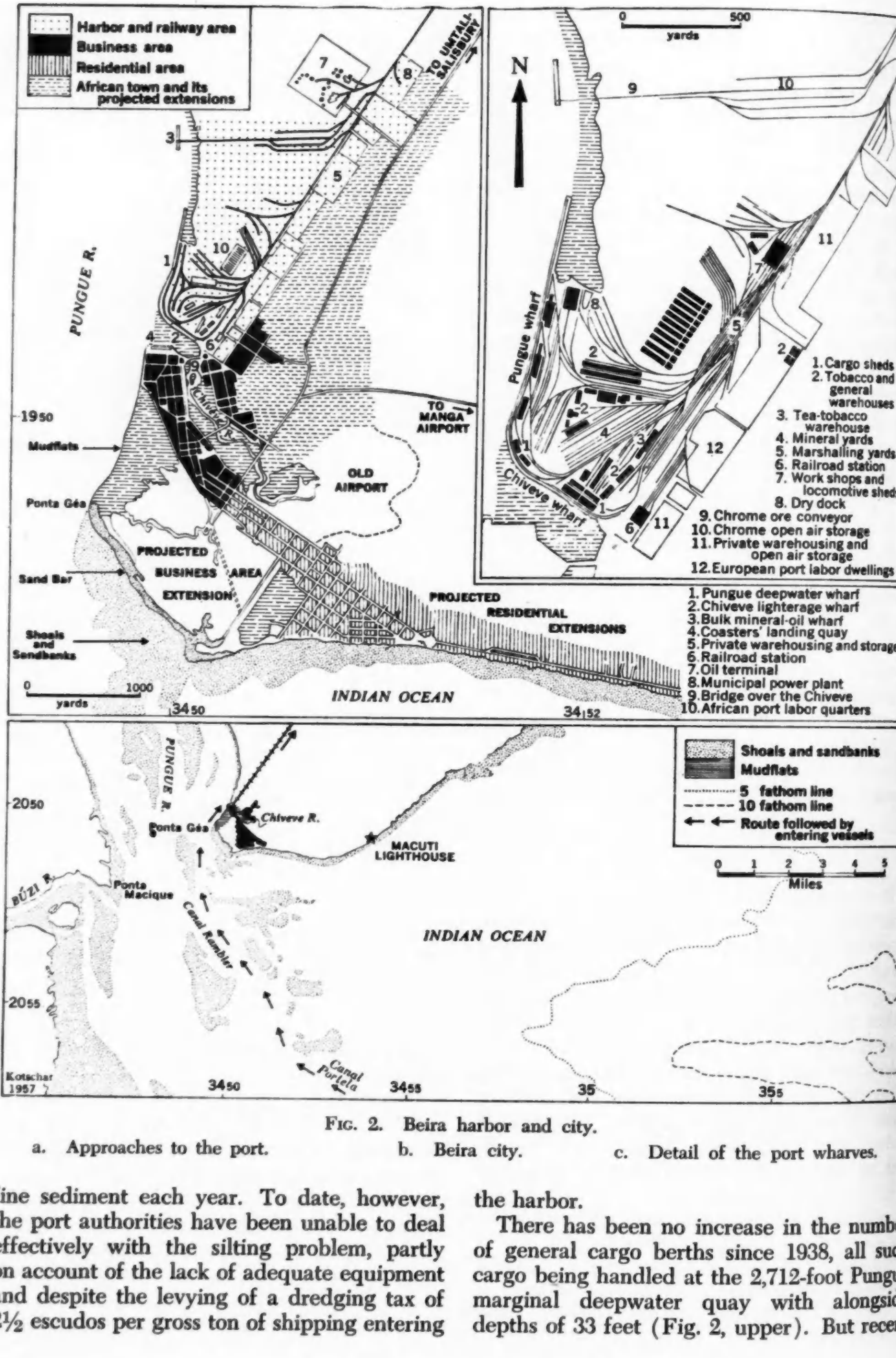


FIG. 2. Beira harbor and city.
a. Approaches to the port. b. Beira city. c. Detail of the port wharves.

fine sediment each year. To date, however, the port authorities have been unable to deal effectively with the silting problem, partly on account of the lack of adequate equipment and despite the levying of a dredging tax of 2½ escudos per gross ton of shipping entering the harbor.

There has been no increase in the number of general cargo berths since 1938, all such cargo being handled at the 2,712-foot Pungue marginal deepwater quay with alongside depths of 33 feet (Fig. 2, upper). But recent

mechanization and reorganization of operations, plus a limited increase in shed and storage space, have raised the potential port handling capacity, placed at 2.1 million harbor tons in 1950, to 3.5 million tons in 1954, after completion of chrome ore bulk loading facilities. Traffic pressure continues, and the port is worked on a 20-hour a day basis, but congestion has been eliminated except for periods when a number of ships arrive simultaneously.

The new T-head pier that supports the chrome ore conveyor belt is used also for the berthage of tankers. Liquid fuels in bulk are conducted by three pipelines to a tank farm just beyond the harbor area operated by four petroleum marketing companies.

Ultimately, the tidal marsh behind berth 5 will be filled in and the quay will be extended to the mineral wharf to provide two additional berths and a more rational use of storage space and tracking for berths 4 and 5. Much level ground is available at the port site either for wharf extensions or for railway marshalling yards, but the difficulties of an unstable ground are an inhibiting factor for port development. Special methods of construction must be adopted, and the present berths require frequent reinforcing with resultant loss of working time. Even for anchorage the harbor's holding grounds are poor, unless ships moor at the six specially installed buoys where they can be worked by lighters. When no berth or buoy is vacant, shipmasters often prefer waiting in the roadstead to the danger of fouling the anchor in soft mud and becoming wrecks in the inner harbor.

Beira's 1,471-foot lighterage wharf and an unimproved landing quay for small coasters are located on both sides of the Chiveve, a short, muddy stream that winds through the business city before entering the Pungue. Lighterage operations at Chiveve, handled by two private contractors, play an important role in port activities, for up to 400,000 harbor tons may be moved yearly over the lighterage wharf. Yet this area also suffers from unfavorable site features. The quays are cramped and water depths are such that boats literally rest on the mud bottom at low tide (Fig. 3).

Another defect at Beira, affecting the harbor

FIG. 3. The mouth of the Chiveve stream at low tide. Note boat resting on mud bottom at small coasters' quay. Across it, to the right, is a section of the lighterage wharf.

operations both at Pungue and Chiveve wharfs, is the great difference in tides, previously described as assisting the entry of vessels, but causing hardships at the docks in cranage work. Loading and unloading operations have sometimes to be stopped for several hours because the ship sits too high or too low in the water.

To overcome Beira's site deficiencies and to reduce maintenance expenditure, a system of closed basins or one large locked dock have recently been advocated by some visiting harbor construction experts. Although publicized in the local press[9] this solution has evoked little response outside of Beira.

The city itself (Fig. 2, upper left) is constantly faced with the same terrain problem that plagues the harbor. Deep foundation piles have to be sunk for all buildings, which increases construction costs. The edges of urban land have to be defended against the effect of tidal and river currents by fortifying walls, while strong marine erosion from Ponta Géa to Macuti Lighthouse repeatedly threatens the ocean beach, the pride of the city and the direction of its present growth. Prior to 1948, Beira grew in a disorderly manner and was described abroad as "a shanty town on a mud spit." Sanitation was practically non-existent; water for domestic and other purposes was available only from rain-collecting tanks. Since 1948–49 handsome residential and business sections have been constructed, a municipal water supply from artesian wells has been inaugurated, and a new power and lighting system has been installed.

There has also been a considerable increase in manufacturing, with establishments catering to the construction industry, tobacco processing, flour milling, edible oil extracting, soap and furniture factories being represented. A new international airport was recently completed, partly with U. S. funds, at Manga, just outside the town, and Beira has become a focus not only for land-sea connections but for several inter-African air routes. The population of Beira, which is rising with some rapidity, was about 18,000 Europeans and 35,000 Africans in 1954.

### THE BEIRA RAILWAY

The single track, 3 ft.–6 in. gauge Beira Railway extends 204 miles from Beira to Umtali. For 40 miles it traverses the vast Pungue alluvial coastal plain, and then climbs through broken, rugged and forested country from an elevation of 342 feet to 3,550 feet at Machipanda, the present Portuguese frontier post. Despite some recent realignments, the route is still very tortuous. Initial inadequate preparation of the road-bed causes excessive vibration on the passage of trains, resulting in unusual wear and tear on locomotives and rolling stock as well as rapid deterioration of track. Numerous sharp curves and gradients up to 3 percent restrict speed in this mountainous section and limit train load capacity to 800 tons instead of possible 1,500-ton loads.

In the coastal section alignments and grades are satisfactory, but in the rainy season Pungue Flats are often flooded, which weakens the subsoil supporting the track. Several long viaducts and bridges on this stretch also limit train speeds.

The inability of the Beira Railway to increase through-movement of goods has long acted as a ceiling on Beira's trade and contributed in a major way to congestion at the port. Through traffic by road has been negligible, on account of customs barriers and the state of the Umtali-Beira highway. Double tracking of the line has been proposed as a solution, but authorities display a natural reluctance to perpetuate the poor physical characteristics of the present railroad. The capacity of the existing line has been raised by providing longer sidings and better signaling, which, with a gradual build-up of motive power and rolling stock,[10] has permitted increasing the daily train movement from 9 to 15 trains in each direction. The present capacity of the line may be estimated at about 3 million tons. Except for an occasional emergency, there is no railway fuel problem, for Moatize in Mozambique and to a lesser extent Wankie in Southern Rhodesia supply the necessary coal. Dieselization has not been pushed, since there is a prospect of electrification with power obtained from the Revue hydroelectric scheme. Some shortages of labor have been detrimental to maintenance of the

[9] J. Oliveira da Silva, "O Porto interior de que a Beira necessita," *Diário de Moçambique* (Beira), April 8, 12, 15, 1954.

[10] At the time of nationalization the line had no rolling stock whatsoever and only three old locomotives, the previous owners having operated with rolling stock of the Rhodesia Railways, which was returned to the latter under the terms of the purchase agreement.

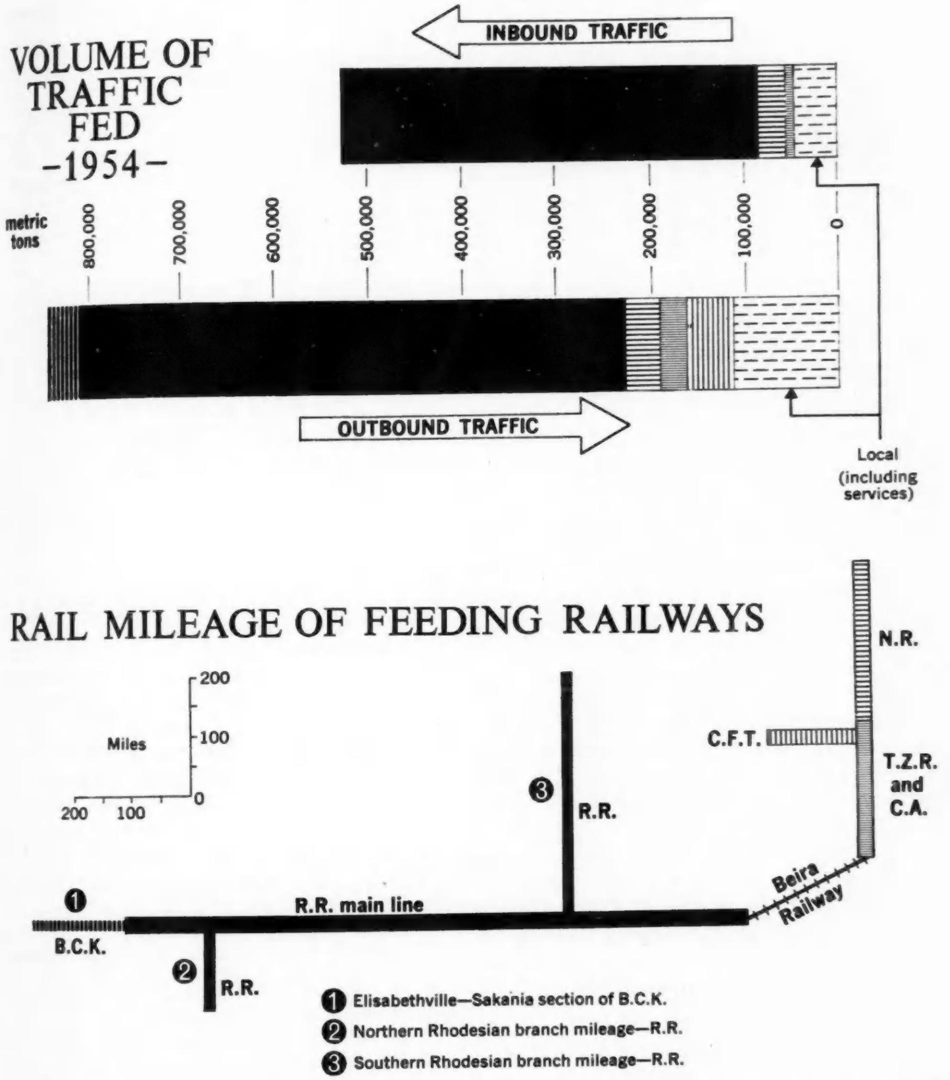


FIG. 4. Schematic presentation (below) of the rail systems connecting with the Beira Railway. The volume of traffic fed by each system is indicated in corresponding symbols in the bar chart above.

way, and it was only in 1954 that the Railway acquired its own workshop at Machipanda, having previously relied entirely on the Rhodesia Railways' repair facilities.

The volume of Beira Railway traffic interchanges with its various feeding systems in 1954 and the mileage of its rail feeders is illustrated by Fig. 4. During that year the total volume of through traffic movements, 2,430,152 tons, was much greater than the volume of local traffic movement, 318,342 tons, while receipts from the former, 277,544 contos, far outweighed those from local traffic, only 9,792 contos. The heaviest movement of goods was downward, 1,467,957 metric tons as compared with 1,043,956 metric tons upline.

TABLE 3.—ORIGIN AND DESTINATION OF EXTRA-NATIONAL TRAFFIC FLOW THROUGH BEIRA PORT, BY COUNTRY, IN 1948 AND 1954[1]

(Volumes in '000 metric tons; Values in '000 contos, 1 conto = $35.7)

| Year | | Rhodesias | | Nyasaland | | Belgian Congo | |
|---|---|---|---|---|---|---|---|
| | | From | To | From | To | From | To |
| 1948 | Volume | 521.9 | 401.9 | 22.7 | 37.7 | 76.4 | 6.3 |
| | Value | 2,430.5 | 2,027.8 | 370.7 | 330.7 | 220.5 | 26.9 |
| 1954 | Volume | 904.9 | 683.2 | 56.9 | 60.7 | 95.0 | 6.6 |
| | Value | 3,942.7 | 3,428.0 | 510.2 | 474.4 | 344.7 | 83.6 |

[1] Source: Mozambique, Repartição Técnica de Estatística, *Comércio Externo 1952, 1954* (Lourenço Marques, 1953, 1955), pp. xv–xvi.

### PORT HINTERLANDS

A breakdown of port traffic by interior origin and destination reveals that the transit flow from the Rhodesias dominates the picture (Table 3). That portion of Beira's extra-national hinterland is delimited by the sphere of action of the Rhodesia Railways[11] supplemented by the railway administration motor services and private road transport. The second share of extra-national hinterland corresponds to the area served by the Nyasaland Railways. A third outside area, partially tributary to Beira because of certain institutional arrangements, is the Upper Katanga region of the Belgian Congo served by the Elisabethville-Sakania rail section of B.C.K. A portion of the mineral shipments of *Union Minière du Haut Katanga* and some supplies for that concern move via Beira.

The national hinterland of Beira covers the former province of Manica and Sofala, reorganized in 1954–55 into the Manica and Sofala, and Tete districts, roughly three-tenths of Mozambique.[12] The approximate boundaries of Beira's hinterlands are shown in Fig. 1.

### THE NATIONAL HINTERLAND

As a gateway for the domestic external trade of Mozambique, Beira customs district ranks second to Lourenço Marques, which had a slightly higher volume of shipments in 1954 (482,629 tons against Beira's 306,965 tons), but a value of shipments 2 2/3 that of Beira (1,993,244 contos as compared with 783,888 contos for Beira.)[13] The greater import requirements of the capital city largely explain the higher value of Lourenço Marques' domestic traffic. Also, Beira's national hinterland (Fig. 5) is sparsely settled[14] and no major effort was made to develop its latent resources until 1948–49.

According to the census of 1950, the portion of Mozambique Province served by Beira contained at that date 1,028,056 Africans and 20,568 "civilizados," as compared to an African population of 1,393,805 and 42,603 "civilizados" in the area served by Lourenço Marques.[15] The density of population for Beira's hinterland was 11.7 persons per square mile while that for Lourenço Marques was 30.3. The number of whites has increased since 1950 in both areas, and although exact figures are

[11] In addition to the Rhodesian network proper, totaling 1,989 miles of rail, the Rhodesia Railways also own the 510-mile section passing through Bechuanaland Protectorate between Plumtree on the Southern Rhodesian border and Vryburg in the Union. This section, together with the 69-mile stretch south of Bulawayo, is, however, operated by the South African Railways administration.

[12] It is not intended in this paper to deal with Beira's national tributary areas which are reached otherwise than by overland connections, e.g., through coasting trade or by plane.

[13] Table XI in Mozambique, Repartição Técnica de Estatística, *Comércio Externo, 1954* (Lourenço Marques, 1955). These data pertain to entire customs districts but also can be taken as fairly representative of the port situation proper in the absence of more detailed information.

[14] See population distribution maps in J. Oliveira Boléo, *Moçambique* (Lisbon, 1951), p. 180; G. T. Trewartha and W. Zelinsky, "Population Patterns in Tropical Africa," *Annals*, Association of American Geographers, Vol. XLIX (1954), Fig. 1a.

[15] See discussion of Lourenço Marques tributary areas in W. A. Hance and I. S. van Dongen, "Lourenço Marques in Delagoa Bay," *Economic Geography*, Vol. 33 (1957), pp. 230–256. "Civilizados" are defined in Mozambique statistics as Europeans, Asians, persons of mixed racial origin, and Africans having adopted European customs. All population figures are from: Mozambique, Repartição Técnica de Estatística, *Anuário Estatístico*, 1954 (Lourenço Marques, 1955), pp. 21–22.

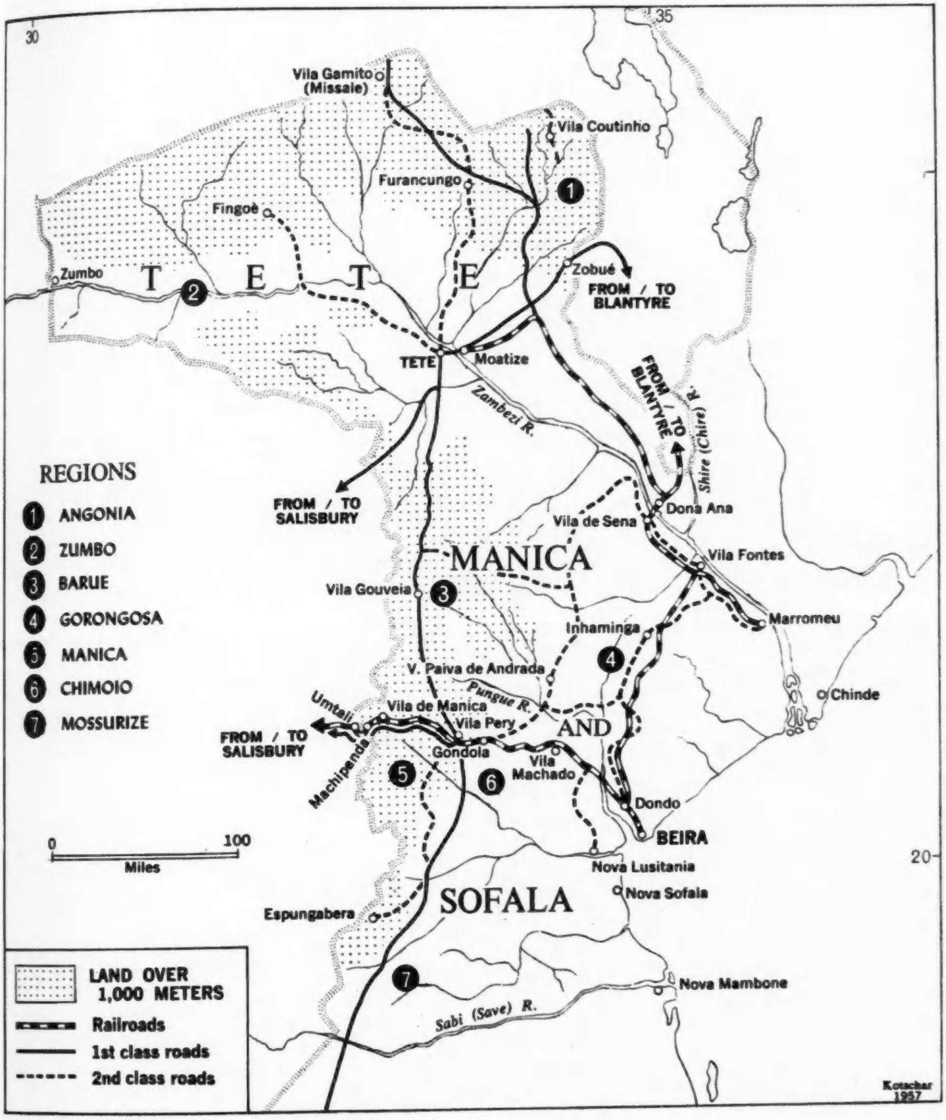


FIG. 5. Beira's national tributary area.

not available, it is not likely that Beira's relative position has improved. There is only a thin veneer of agricultural colonists to be found on the Manica-Sofala plateau, a continuation of the Rhodesian High Veld, despite the availability of an estimated 15 million acres suitable for agriculture and with a climate favorable for white settlement, especially in the Chimoio uplands.[16]

The main commodity shipped seaward by rail from the country west of Beira is maize—

[16] See J. J. Costa, Jr., "O Planalto de Manica e a Colonização Europeia" in *Notícias* (Lourenço Marques), Nov. 20, 1952; also a series of articles by the same author, "Por Terras de Chimoio" in *Notícias*, Dec. 4–27, 1953.

the outstanding crop of the white farmer—together with some oilseeds and oil cake (groundnuts and sunflower), fruit, potatoes, beans, sisal, and small quantities of rice and wheat. Recently, tobacco has been acquiring prominence. Some cotton fiber destined for metropolitan Portugal's textile industry is fed to the Beira Railway from cotton concessions operating in the Gorongoza and Chimoio areas. Timber traffic from several sawmills located along the rail line has been especially important and a forestry mission was sent from Portugal in 1948 to survey local forest resources. Much of the total domestic seaward flow (236,563 tons in 1954), however, supplies the urban market of Beira and is not destined for overseas markets.

Major items in the ascending traffic, totalling 81,799 tons in 1954,[17] are petroleum products, cement from the new plant inaugurated at Dondo in 1950, and sugar from the estates at the mouth of the Buzi River. Manufactured products from overseas or from Beira warehouses move inland in limited quantities because the purchasing capacity of the farmers in the interior is not high. Mining activity, which could give a more profitable livelihood, is restricted in the western highlands to small diggings of gold, copper, tin, and mica.

Excepting Beira itself, the largest clusters of population along the Beira Railway are Dondo and Vila Pery, the center of the Chimoio. The former, a rail junction 20 miles from the seaboard, has been developing as a sort of industrial satellite of the port city as a result of its favorable location for assembly of raw materials and distribution of manufactured products. Besides the cement factory, there is a milling industry and a fibrous cement ("Lusalite") plant using local cement and Southern Rhodesian asbestos, which has shipped its products as far as British East

[17] The total domestic traffic of the Beira Railway is thus 318,362 tons, but only 216,357 tons are commercial traffic, the rest being carried for the railway itself.

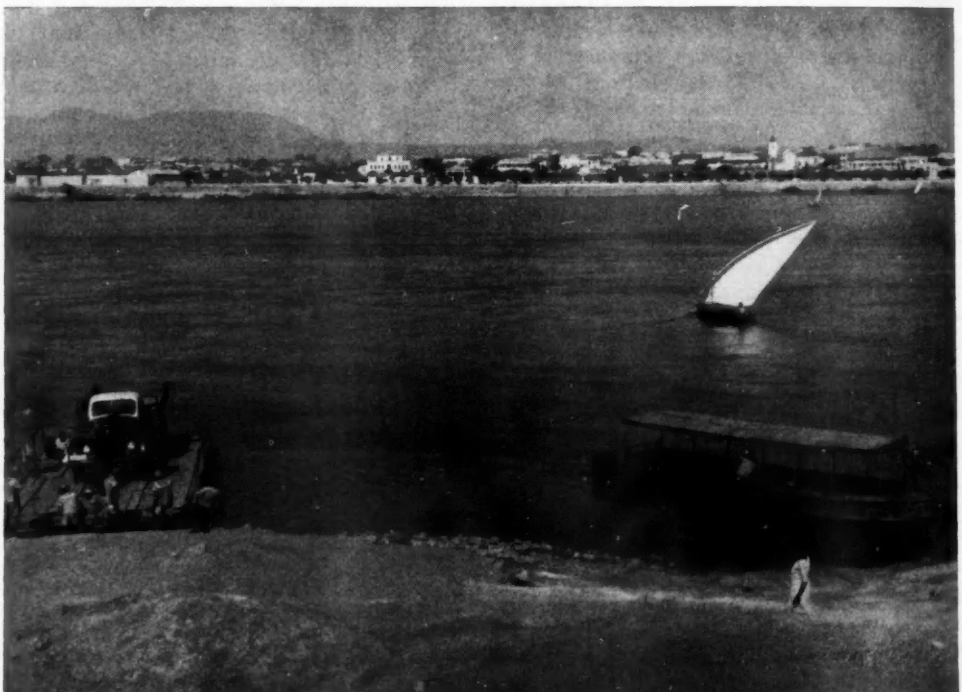

Fig. 6. Tete town on the right bank of the Zambezi River, the farthest point of Beira's national hinterland to be reached by rail. The ferry in the foreground is used by motor traffic employing the Salisbury-Blantyre road connection through Mozambique. (*Courtesy Federal Information Department.*)

FIG. 7. One of the numerous sawmills adjoining the Trans-Zambezia Railway line near Inhaminga. Timber traffic is all important in Beira's national hinterland. (*Courtesy Mozambique Statistical Department.*)

Africa and Mauritius. Vila Pery, a small agricultural products processing center, has received special notice recently because of the establishment of the first textile plant in the Province. The power for the new cotton mills and some jute mills nearby is obtained from the Revue River hydroelectric scheme whose primary installed capacity was 13,200 kw. in 1954.

A second part of the national hinterland is the remote region of Tete in the northwest, which is still undeveloped though it was penetrated as early as the 17th century by seekers of the legendary gold-rich kingdom of Ophir. Ninety-seven percent of the total outward traffic (109,646 tons in 1954) on the Tete Railway is coal from the Moatize field. A trickle of petroleum products and 573 tons of general cargo, of which 371 tons were salt, moved inward in 1954 for the Tete district from the port of Beira. Cotton, groundnuts, and small surpluses of food staples raised in the fertile Zambezi Valley by African river tribes, usually follow the less expensive waterway to the sea either by canoe or by barge (82,241 tons in 1953). The Zambezi is navigable for 9 months of the year from 37 miles above Tete (Fig. 6) to Chinde. This small port, the existence of which is alternately threatened by sands and by the sea, is visited by about a hundred cabotage vessels yearly, and continues to handle local traffic from the Zambezi sugar plantations.

Between Vila de Sena and Dondo junction, 80 percent of the local traffic offered north of Beira is timber and timber products from large and small sawmills working the light forest stands north and south of Inhaminga (Fig. 7). A large part of these products is used by the railroad or at Beira, about one-quarter is exported by sea, and additional quantities move inland by rail to Rhodesia and even to the Union. Ascending domestic movements on this section are small (about 10,000 tons of a total traffic of 60,000 tons in 1954), and are of the same nature as those on the Dondo-Machipanda section of the Beira Railway.

It is apparent that Beira's national hinterland has thus far provided little sustenance for port activities. But what are its potentialities? The development of substantial agricultural exports is not likely for some time because the latest government-sponsored white settlement and development programs are concentrating

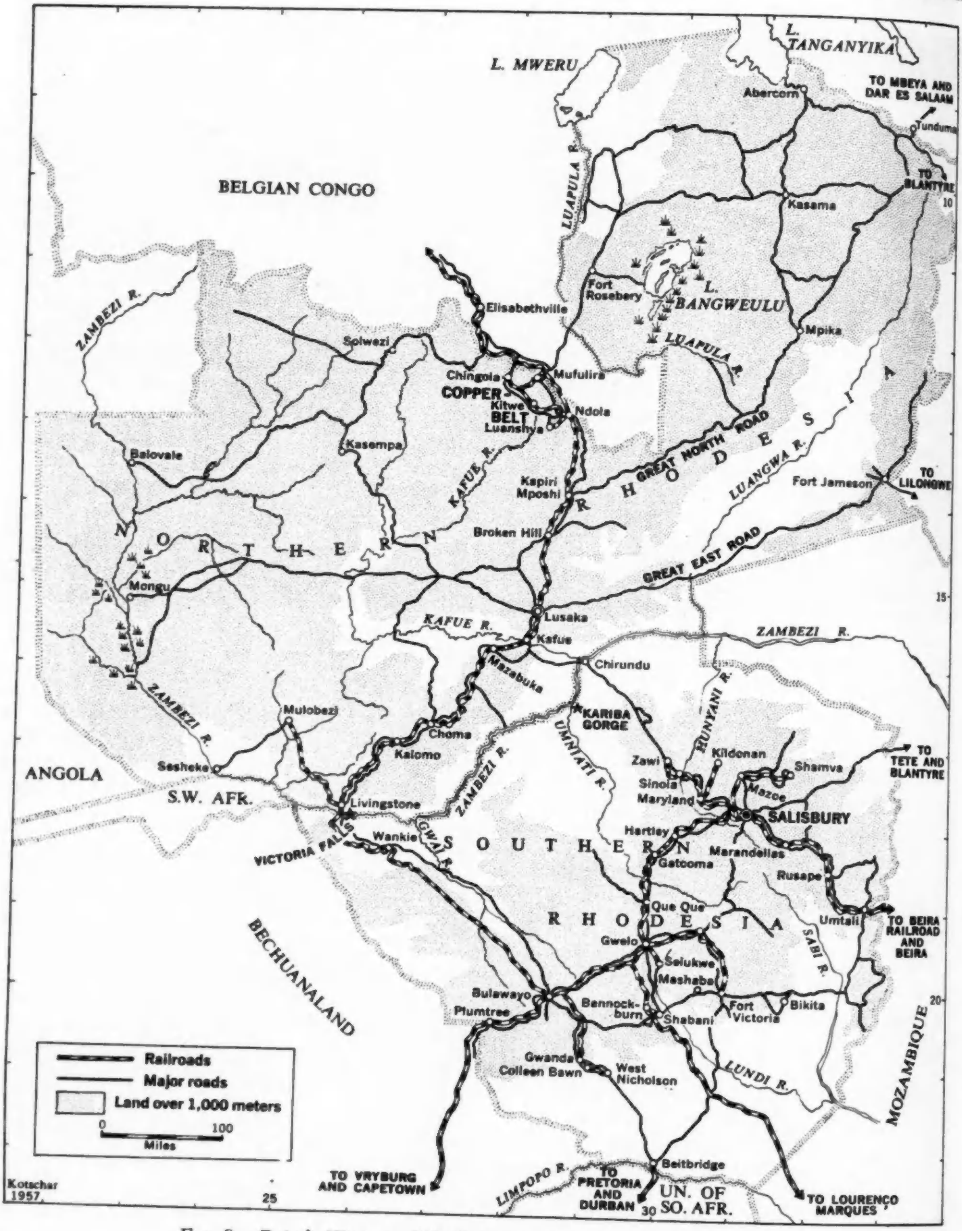


FIG. 8. Beira's Western (Rhodesian) extra-national tributary area.

on other areas of Mozambique, specifically on the Limpopo Valley and on the northern highlands along Lake Nyasa.[18] The few white agriculturalists in the highlands west of Beira have been left largely on their own. The Pungue Flats are farmed by Africans on a subsistence basis though they are suitable for large-scale mechanized cultivation. As for the region

[18] Portugal, Ministérios da Economia e do Ultramar, *Plano do Fomento* (Lisbon, 1953) Vol. I.

south of Beira, it remains practically a "no-man's land" except for a few coastal fishing communities which cater to the Beira market.

Except for the sugar interests at the mouth of Buzi River and elsewhere, which intend shortly to raise their annual production from 90,000 to 150,000 tons and which are capable of financing their own expansion, the development of farming production in Beira's hinterland is likely to be a very gradual process.

Timber exploitation, pursued by 85 to 90 concessionaries, may well expand and can do so without overcutting as there is an effective afforestation program. Stands of eucalyptus have been planted for tannin and a plywood and veneer factory is forthcoming. Other industries which may be attracted by Revue power will probably be directed largely toward producing manufactured goods for internal consumption.

The mineralogically promising Tete district, on the other hand, holds considerable hope for increased shipments. The Moatize coal fields, exploited by a Belgian company, are reported to have some 200 million tons of proved reserves, though the yearly production has not exceeded 120,000 metric tons a year. If substantial quantities of coking coal prove to be available a considerable export by sea might be developed. Large-scale hematite and magnetite deposits had been partially surveyed before the Portuguese, with the help of M.S.A. funds, engaged an American company to conduct a two-year general geological survey of the area.[19] It has been suggested that an iron and steel mill be erected in the Tete area, but many factors, including the remoteness of the area, argue against such a step at this early stage of industrial development in the Province. Of considerable potential interest is the presence of copper ores near the Rhodesian border, and of uranium ores, on which the mining rights have recently been reserved by the Portuguese government's *Junta de Energía Nuclear*. After long reluctance to admit foreign capital in mining, the Portuguese did grant in 1954 extensive prospecting and mining

[19] The results of this survey have not yet been released. For an earlier assessment of Tete mineral occurrences, see J. Oliveira Boléo, *op. cit.*, pp. 393–404; C. F. Spence, *The Portuguese Colony of Mozambique; Economic and Commercial Conditions* (Cape Town, 1951), pp. 35–50.

TABLE 4.—PRINCIPAL COMMODITIES EXPORTED THROUGH THE PORT OF BEIRA IN 1938, 1948, 1953 FROM EACH BRITISH CENTRAL AFRICAN TERRITORY[1]
(Values in '000 £; volumes in short tons)

| Commodity and territory | 1938 Volume | 1938 Value | 1948 Volume | 1948 Value | 1953 Volume | 1953 Value |
|---|---|---|---|---|---|---|
| *Northern Rhodesia* | | | | | | |
| Copper | 242,342 | 8,735 | 229,269 | 22,715 | 409,375 | 85,123 |
| Lead | —— | —— | 6,670 | 518 | 3,355 | 246 |
| Zinc | 4,904 | 63 | 11,020 | 707 | 14,276 | 930 |
| Cobalt | 4,039 | 475 | 1,188 | 194 | 1,562 | 1,053 |
| Vanadic oxide | 804 | 281 | 174 | 91 | 168 | 5 |
| *Southern Rhodesia* | | | | | | |
| Unmanufactured tobacco | 10,026 | 1,085 | 33,180 | 11,014 | 41,902 | 18,508 |
| Cattle hides | 2,611 | 98 | 4,477 | 597 | 5,370 | 853 |
| Maize | 35,774 | 145 | —— | —— | 141 | 6 |
| Chrome ore | 225,627 | 515 | 243,046 | 1,113 | 456,160 | 3,760 |
| Asbestos fiber | 58,137 | 1,265 | 65,576 | 2,855 | 68,040 | 6,438 |
| *Nyasaland* | | | | | | |
| Beans | —— | —— | 848 | 15 | 824 | 33 |
| Maize | —— | —— | —— | —— | 8,189 | 175 |
| Rice | 30 | —— | 2 | —— | 950 | 72 |
| Unmanufactured tobacco | 6,732 | 393 | 11,134 | 2,176 | 11,419 | 2,637 |
| Tea | 5,073 | 445 | 7,190 | 1,289 | 6,162 | 1,482 |
| Cotton fiber | 3,426 | 100 | 2,394 | 363 | 3,209 | 788 |
| Cottonseed | 746 | 2 | 415 | 5 | 4,950 | 78 |
| Groundnuts | 7 | —— | 2 | —— | 5,937 | 345 |

[1] Source: British Central African Federation, Central Statistical Office (Salisbury) records.

rights to a Scandinavian firm, *Ake Viking Lillas.*

### THE EXTRA-NATIONAL HINTERLAND

The dependence of British Central Africa on Beira has been very great. In a normal post-war year, Beira has handled 65 percent of the total external trade by value of the Federation and 80 percent of the total overseas trade.[20] The difference in these percentages is represented by the trade between the Union and the Federation, most of which moves by rail over the line south of Bulawayo, across the Bechuanaland Protectorate. In 1954, traffic interchanges at the Federation's southwestern border totaled about 900,000 short tons in comparison with about 2,200,000 short tons moving in and out over the Federation's eastern border at Umtali.[21] Some 140,000 short tons of Federation traffic also moved from Nyasaland across the Mozambique border at Port Herald.

[20] In 1954, the value of Federation trade that passed through Beira port was £178,109,275 as compared with £26,702,952 moving via Union of South Africa harbors. Federation of Rhodesia and Nyasaland, Central African Statistical Office, *Annual Statement of External Trade, 1954* (Salisbury, Government Printer, 1955), Table XI, and information supplied directly by C.A.S.O. Trade using Lobito, the only other port of significance to the Federation, consisted to 1956 almost entirely of emergency coal shipments to the Copperbelt of Northern Rhodesia.

### RHODESIAN EXPORT FLOW TOWARD BEIRA

Shipments from Beira's Rhodesian hinterland (Fig. 8), covering some 440,000 square miles, are considerably heavier than inward traffic, which is explained by the fact that the exports are predominantly minerals. In the mid-fifties these mineral out-movements totaled 1 to 1.1 million short tons as compared with some 100,000 tons of all other outgoing goods. The type of Rhodesian exports also explains why the Mozambique port handles 127 times as much of the outgoing Rhodesias' trade

[21] Rhodesia Railways, *Report of the General Manager for the Year Ended 31st March 1955* (Bulawayo, December 1955), pp. 7–11.

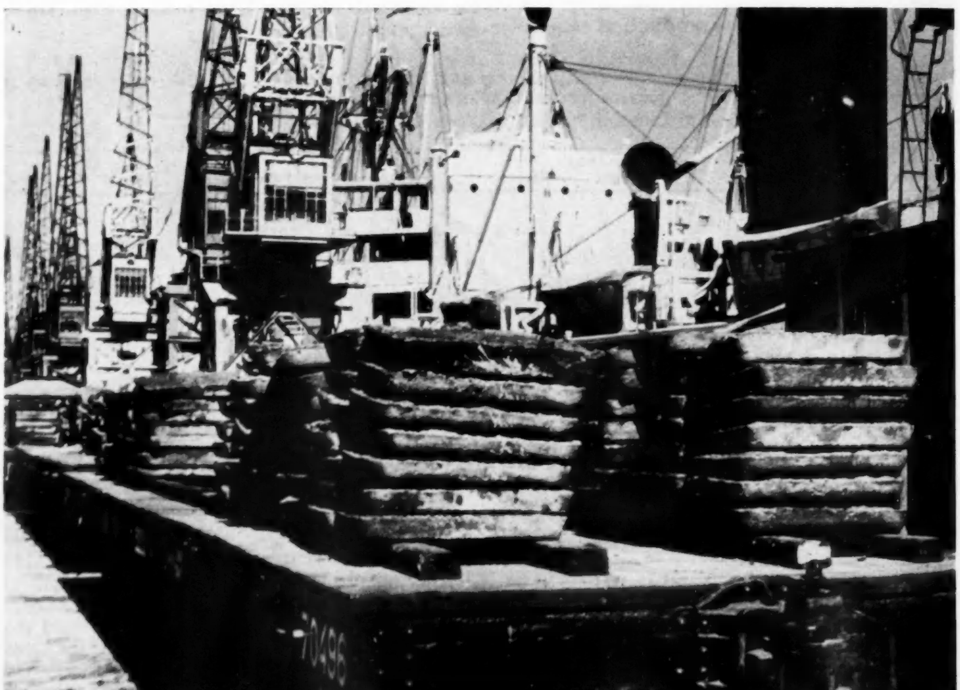

FIG. 9. Blister ingots ready to be loaded aboard ship at Pungue wharf. Copper shipments from the Northern Rhodesian Copperbelt are the most valuable extra-territorial exports through Beira.

by value as do the Union ports, whereas it handles only twice the value of incoming trade. Table 4 shows the changes that took place in the volume and value of principal commodities exported from British Central Africa through Beira, by originating territory, between 1938 and 1953. Since 1954, only total Federation figures are available.

Copper shipments from the four great mines of the Copperbelt[22] (valued at about £100 million in 1955) have long been the most important Central African commodity shipped through Beira (Fig. 9). A long-standing agreement between the copper producers and the Rhodesian rail authorities involving special rates on copper metal and on coal and timber moving to the mines has served to compel the movement of copper to Beira even during periods of severe congestion. Beira has naturally benefited greatly from the rise of the Copperbelt in postwar years to the position of second world producer.[23] Cobalt alloy and, since 1952, cobalt metal from the Copperbelt have also moved to Beira. In 1954, production of blister copper reached 230,000 short tons, of electrolytic copper 194,000 tons, and of cobalt 1,800 tons.

A close second in tonnage shipments to Beira has been the chrome ore traffic from the mines in the Lomagundi and Selukwe areas of the Southern Rhodesian High Veld. The 23-mile Selukwe-Gwelo branch and the 24-mile Kildonan-Maryland (or Umvukwes) sub-branch were built to bring local chrome ore to the main line. Chrome producers have been plagued with an almost continuous shortage of freight cars, resulting in accumulation of large stockpiles in the mining areas (at present an estimated year's production) and periodic failure to meet export commitments, or inability to accept orders from overseas. The ferrochrome plant at Gwelo, erected in the early fifties, has been operating on a restricted scale pending additional supplies of power. Also, the chrome mining companies, affiliated with large metallurgical concerns abroad, have not fully utilized the plant, preferring to ship their output in a form more easily dealt with abroad.

Another bulk mineral export from Southern Rhodesia, asbestos, of which 80,000 tons were produced in 1954, has also suffered from rolling stock shortages (Fig. 10). The 62-mile Shabani to Somabula branch was constructed to bring out asbestos from the chief site, Shabani, which is connected with the second largest producer at Mashaba by a 35-mile, asphalted road. The branch is owned by the asbestos companies and operated for them by the Rhodesia Railways.

The latest rapidly growing mineral export from Southern Rhodesia is petalite, a lithium ore now mined at a rate of 10,000 tons a month, chiefly at Bikita, 40 miles by road from the railhead at Fort Victoria. Although 60,000 tons of petalite were exported over the Umtali-Beira line in 1955, it will now probably move via the Limpopo Railway, thus avoiding congestion on the Beira Line.

The other Rhodesian mineral exports, including lead, zinc, and vanadium, worked since 1904 at Broken Hill in Northern Rhodesia, and gold, mica, and tungsten, obtained in scattered locations on the Southern Rhodesian High Veld, have not attained sufficient volume to suffer severe delays in moving to Beira. Furthermore, from two-thirds to three-quarters of the combined lead-zinc output (about 40–45,000 tons a year) is marketed in the Union and moves southward over the Mafeking line.[24]

Of the agricultural commodities moving towards Beira from the Rhodesias, unmanufactured leaf tobacco from Southern Rhodesia ranks first in volume (50–60,000 tons in 1954–55), while it ranks second in value to copper among total exports. The phenomenal develop-

[22] The Roan Antelope Mine near Luanshya, Mufulira Mine at Mufulira, Nkana Mine near Kitwe, and Nchanga Mine at Chingola. A fifth large mine, Chibuluma, at Kalulushi entered active production in May 1956, and a sixth one, Bancroft, came into operation in 1957.

[23] A brief summary of the present position of the Northern Rhodesia copper mining industry may be found in "Vast Copper Resources in Northern Rhodesia," in *East Africa and Rhodesia*, January 13, 1955, pp. 614–615. See also: H. W. Woodruff and C. H. Thompson, *Economic Development in Rhodesia and Nyasaland* (London, 1955), pp. 158–160; U. S. Department of Commerce, *Investment in Federation of Rhodesia and Nyasaland* (Washington D. C., 1956), pp. 21–25.

[24] For additional material regarding Federation mining, see "The Mining Industry of the Federation, 1949–54," in Federation of Rhodesia and Nyasaland, Central African Statistical Office, *Monthly Digest of Statistics*, Vol. II (April 1955), pp. iii–xvii. D. Whittlesey presented a historical sketch of mining developments in Southern Rhodesia in "Southern Rhodesia—An African Compage," *Annals*, Association of American Geographers, Vol. XLVI (1956), pp. 31–37.

FIG. 10. Asbestos fiber (at Shabani, Southern Rhodesia) awaiting railage to Beira. (*Courtesy Federal Information Department.*)

ment of quality tobacco production in the Rhodesias (Fig. 11) is relatively recent and reflects the postwar necessity of the British Commonwealth to reduce customary large dollar expenditure for tobacco imports. Present agreements between British manufacturers and Southern Rhodesia provide for the purchase of at least two-thirds of the current crop. Virginia flue-cured tobacco, and smaller quantities of fire-cured, Burley and Turkish varieties, are produced by European farmers on the High Veld, chiefly in the Lomagundi (Sinoia), Salisbury, Makoni (Rusape), Marandellas, and Hartley districts. Southern Rhodesia's flue-cured production totaled around 110 million pounds in 1954. Some 10 million pounds of flue-cured tobacco is also produced on European farms in Northern Rhodesia along the rail belt from Choma through Mazabuka and Lusaka up to Broken Hill. The yearly crop of both territories is auctioned on the floors at Salisbury, also the regional center for tobacco manufacturing.[25] After the auctions the tobacco is packed in hogsheads, boxes, or bales, and moves by rail via Umtali to the sea.

Maize exports through Beira were formerly important from Southern Rhodesia, but a rapidly expanding population in that country, increased employment in non-farming activities, and an improved standard of living now result in practically entire absorption of the locally grown supply. Maize shipments on the Rhodesian lines, however, have a very great indirect effect on traffic moving to Beira (Fig. 12), for during the marketing season from May to July priorities are given to these shipments, while asbestos and chrome ore producers are left with totally inadequate rolling stock.

[25] A good description of regional tobacco growing is given by P. Scott in "The Tobacco Industry of Southern Rhodesia," *Economic Geography*, Vol. 28 (1952), pp. 189–206. See also G. W. Van Dyne, *Trends in South and East Africa Affecting U. S. Trade in Tobacco* (Washington D. C., Department of Agriculture, Oct. 1950).

FIG. 11. Tobacco fields at a European farm near Lusaka, Northern Rhodesia. Tobacco is the leading Rhodesian agricultural overseas export via Beira. (*Courtesy Northern Rhodesia Information Department.*)

Maize production also causes a similar seasonal problem in inward traffic because Beira handles a heavy volume of fertilizers used by maize and tobacco farmers. Maize growing is most intensive in the Mazoe (Shamva), Salisbury, and Lomagundi districts, the so-called "Maize Belt" of Southern Rhodesia, served by the 73-mile Salisbury to Shamva (or Mazoe) branch and the 103-mile Salisbury to Zawi (or Lomagundi) branch.

Other Rhodesian agricultural products regularly passing over Beira wharves, but in small volume, are vegetable oils and oilseeds, cotton, potatoes, fruit, and canned fruit juice. Although Southern Rhodesia has an important beef and dairy cattle industry, located chiefly in the drier, western Matabeleland, little surplus is available for export. Some bacon, ham, and beef extract, however, are shipped to the United Kingdom from the Cold Storage Commission plant at West Nicholson, and there is a growing export of hides and skins from the African reserves.

Timber produced in the Rhodesias is also destined mainly for the domestic market. Only occasional shipments of Rhodesian teak for flooring reach Beira from the Zambezi Sawmills Co. near Livingstone.

For the future[26] there is good reason to expect continued rapid growth in the export traffic of the Rhodesias. The rate of growth of the gross national product and the extremely high rate of investment (possibly the highest rate in the world in the past decade) promise increased output for sale abroad. Transport improvements and reduced necessity to carry coal after completion of the Kariba scheme should permit the readier movement of goods long bottled up. Copper production may increase

[26] See W. A. Hance, "Economic Potentialities of the Central African Federation," *Political Science Quarterly*, Vol. LXIX (1954), pp. 29–44.

FIG. 12. Seasonal movements of maize (corn) periodically tie up a large share of the carrying capacity on the Rhodesia Railways. For the most part, only rudimentary storage is available at the point of shipment, as at this African village in Southern Rhodesia.

by as much as 100,000 tons while there are numerous possibilities for expansion in output of other minerals. Although agriculture is to some extent the weak link in the Rhodesian chain, there are excellent opportunities for increased sale of tobacco, tea, citrus fruit, animal products, and other commodities. Industrial plants are catering primarily to the domestic market, but there are some possibilities for the sale of manufactured goods abroad, including eventual large-scale exports of pig iron and steel.

#### IMPORTS TO THE RHODESIAS FROM BEIRA

The chief imports moving from Beira into the Rhodesias are petroleum products, construction materials, railroad equipment, softwood lumber, grain (mainly wheat), and fertilizers. Imports of railroad locomotives and rolling stock have been unusually large in the last five years (cf. Table 2) but are not likely to continue so important. Motor vehicles and textiles are also significant, the latter despite the growth of the spinning and weaving industry in Southern Rhodesia, which even exports a portion of its output. In the list of general goods moving westward from Beira it is interesting to note a fairly important tonnage of explosives destined for various mines, salt for African consumption, and paper. Cement imports, formerly second in rank, dropped off after development of cement production at Bulawayo and Colleen Bawn in Southern Rhodesia and at Chilanga in Northern Rhodesia.

Gasoline comprised 175,000 tons of the total 280,000 tons of petroleum products sent to the Rhodesias from Beira in 1954. The Federation's requirements for imported fuels have been somewhat reduced by the availability of coal from Wankie, Southern Rhodesia, and some local hydroelectric developments. Storage for bulk petroleum products exists at Umtali, Salisbury, Bulawayo, Lusaka, and Ndola.

There is little question that imports to the Rhodesias will continue to grow considerably. The character of import traffic may change as domestic industry diversifies, but capital goods requirements will intensify, while the improving standard of living of both Europeans and Africans should stimulate the market for a broad range of consumer goods.

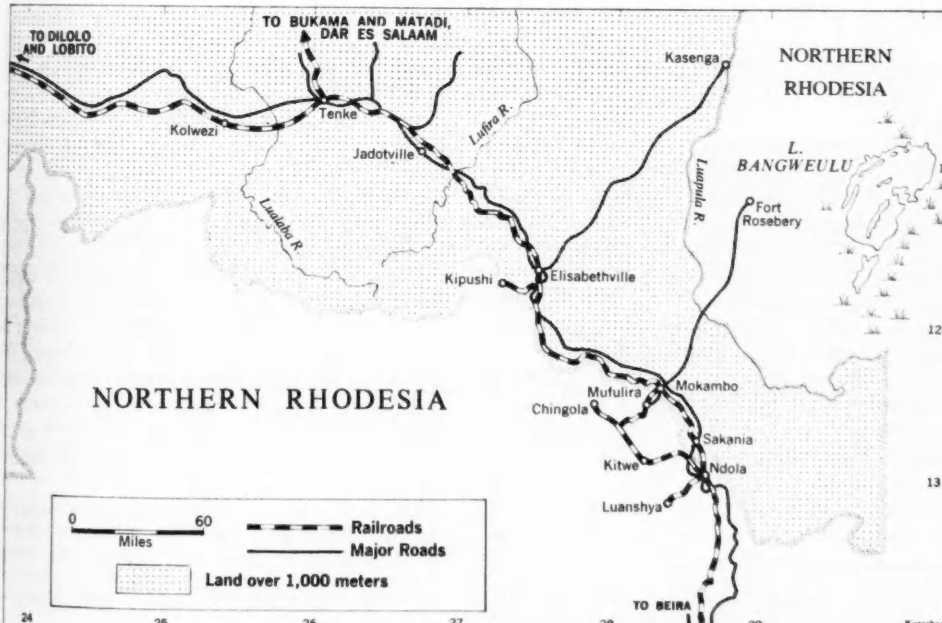


FIG. 13. Beira's Western (U.M.H.K.) extra-national tributary area.

### BELGIAN CONGO TRADE MOVING VIA BEIRA

As noted earlier, a certain part of Katanga trade (Fig. 13) is handled at Beira. The share of Congo imports moving through the port of that city is insignificant, but about 7 percent of exports from the Congo by tonnage and 7 to 11 percent by value are exported via the Rhodesian–Mozambique rail route to Beira.[27]

The export flow from the Congo to Beira consists of minerals and metals. The smelters of *Union Minière* at Lubumbashi (Elisabethville) have been shipping 70–80,000 tons of copper metal and 10–15,000 tons of zinc ingots yearly to Beira. These shipments are handled at Beira by Belgian representatives, stored in Belgian warehouses, and picked up by Belgian ships. These ships visit the eastern coast of Africa at moderate intervals, mainly to land and pick up cargo at "Belbase," a Belgian-owned custom-free enclave at Dar es Salaam used for transit shipments to and from the eastern Congo over the central Tanganyika railroad. Beira is the terminus of Belgian ships on this run.

### CONGESTION ON THE RHODESIA RAILWAYS

Ever since the beginning of the postwar period of accelerated economic development in central Africa there has been evidence of congestion on the Rhodesian rail network. The private company that owned the network prior to nationalization was not prepared for the sudden boom and had no definite expansion program. After nationalization, capacity was doubled, but it is still inadequate. The total tonnage hauled increased from 5.1 million tons in 1949 to 8.6 million tons in 1954, while net ton-mileage increased in the same period from 2,300 to 3,400 million.

The strategic importance of the outward mineral flow from the Rhodesias has made the United States conscious of Central African transport difficulties. Although most of the copper has customarily gone to the United Kingdom, up to 55 percent of Southern Rhodesian chrome ore, a good deal of high-grade asbestos, and much of the cobalt are taken by United States industries. Output of the new petalite development is also shipped mainly to the United States, to a lithium-chemicals plant near San Antonio, Texas. Moreover, there is a strong participation of American capital in a number of mining enterprises, including American Metal Company holdings in the Rhodesian Selection Trust, one of the two controlling powers on the Copperbelt, and in the chrome, asbestos, lithium ore, and recently formed manganese mining companies. American investment has been welcomed in the Rhodesias, and recent government releases have aimed at stimulating additional flow of dollar capital.[28] It is not surprising, therefore, that considerable financial assistance has been extended by official and other United States agencies to help reduce the transport difficulties. These include supply of road making equipment under the ECA in 1949, an ECA loan of $950,000 and a release of 4,250,000 Dutch florins in counterpart funds to finance the bulk mineral wharf at Beira, an ECA loan of $14 million in 1951 to the Rhodesia Railways for general improvement, a 1951 ECA grant of $289,000 to cover half of the reconstruction of the Great North Road from Broken Hill to Tunduma in Northern Rhodesia, and a 1954 FOA loan of $10 million for general railway development in the Federation. The International Bank for Reconstruction and Development extended a loan of $14 million to the Rhodesias and the Export-Import Bank a loan of $17 million to Portugal to finance the Limpopo Railway. Other loans and grants have been made to expand various mining operations and to raise the region's power production including the largest loan ever made by the I.B.R.D. to finance the Kariba Gorge project.

Failure of the Rhodesia Railways to catch up with local demands for railage is explained by a variety of factors ranging from delays in arrivals of locomotives and rolling stock to severe staff problems associated with recruitment and the working performance of some of the technical personnel.[29] There also remains a need for considerable additional capital,

[27] For the position of Beira as a Belgian Congo trade gateway, see W. A. Hance and I. S. van Dongen, "The Port of Matadi (Belgian Congo) and its Hinterland," forthcoming.

[28] Southern Rhodesia, Public Relations Department, *Southern Rhodesia, a Field for Investment* (British Information Service, New York, 1950); Federation of Rhodesia and Nyasaland, Federal Information Department, *Opportunity in Rhodesia and Nyasaland* (Salisbury, 1955).

[29] Rhodesia Railways, *Report by the Investigating Committee* (Bulawayo, 1955).

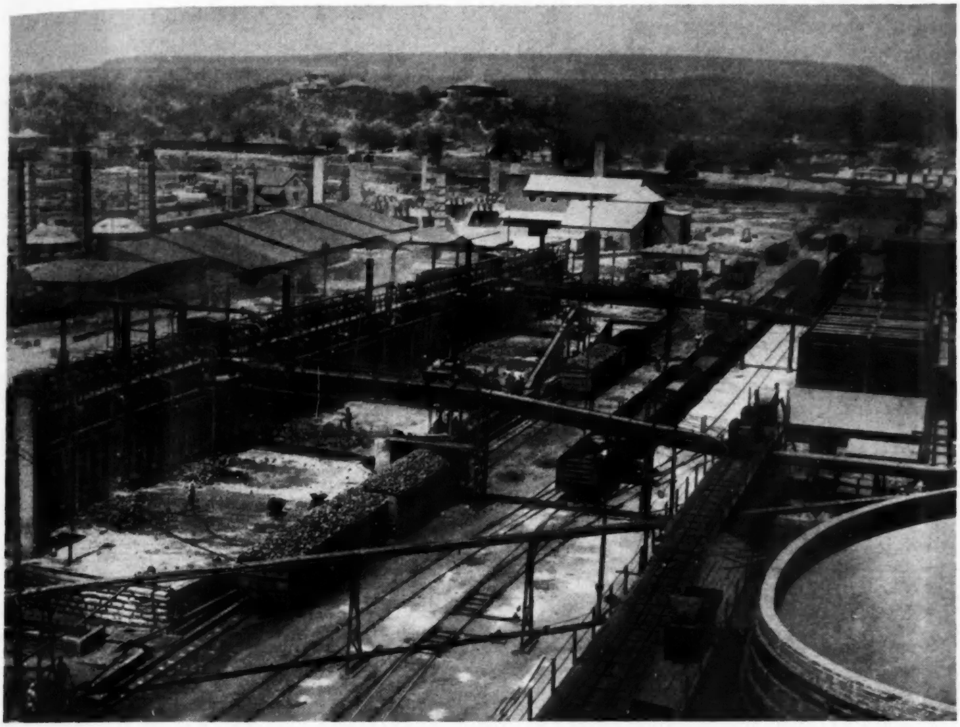

FIG. 14. A view of Wankie colliery with coke-loaded railroad cars. The volume of coke and coal carried by the Rhodesian Railways from Wankie in the western extra-national hinterland of Beira represents one-third of total Rhodesian rail traffic and has been a leading cause of rail transport difficulties on the Rhodesian High Veld. (*Courtesy Federal Information Department.*)

which is not readily forthcoming. Servicing of current loans now represents 12.5 percent of gross railway income. Roads and road transport organizations are not yet sufficiently developed to relieve the hard-pressed railways.

The greatest contribution to congestion is probably the magnitude of regional coal movements (about 3 million tons in 1954). Wankie coal (Fig. 14) is required for smelting in the Katanga and the Copperbelt; it is used by the other mines, in the iron and steel plant at Que Que, in the power plants of Southern Rhodesia, and by the railroad itself. There have been more or less chronic shortages of coal throughout the Rhodesias, sometimes occasioned by inadequate output at Wankie, but more often explained by inability of the railway to move available coal in adequate quantities. As a result, the copper producers have been required to substitute wood and to import coal from the Union (Transvaal) and the United States via the port of Lobito and the Benguela Railway.

The burden of moving coal has also affected the financial position and the expansion program of the Railways. Hauled at nominal rates, coal contributes only 10 to 12 percent of total railroad revenue yet represents one-third of traffic.[30] And reluctance to disturb the present balance of shipments on the Wankie-Copperbelt section of the line has reduced interest on the part of the railway administration in building a direct link between Salisbury and Lusaka via the "Sinoia-Kafue cut-off," which could shorten the route to Beira from the Copperbelt by some 500 miles. Coal may become less of a burden on the Rhodesia Rail-

[30] Rhodesia Railways, *Annual Report 1955, op. cit.,* p. 11.

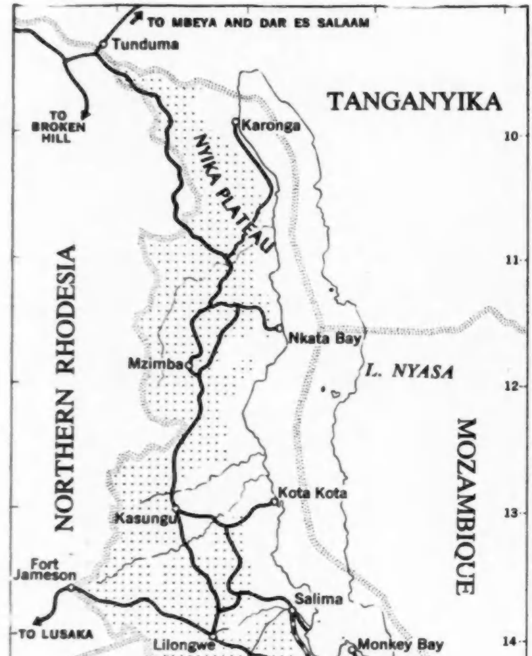


FIG. 15. Beira's Northern tributary area.

ways when the Kariba Gorge hydroelectric scheme, with an original capacity of 500,000 kw. and an eventual capacity of 1,200,000 kw., has been completed.

## THE NORTHERN ROUTE AND THE NYASALAND TRAFFIC FLOW

The northern section of Beira's extra-national hinterland is Nyasaland (Fig. 15). With 37,000 square miles, it is only one-twelfth the size of the two Rhodesias. Although the Protectorate and Northern Rhodesia have a long contiguous border, the surface connections are very restricted; only the Lusaka-Fort Jameson-Lilonwe route (The Great Eastern Road) provides an effective intra-Federal link. A second route, Salisbury-Tete-Blantyre, passes through Portuguese territory and is used for limited auto traffic transferred by manual ferry over the Zambezi. It is estimated that total tonnage moved by road in and out of Nyasaland from all surrounding territories does not exceed 10,000 tons per year.

Nyasaland is served by a rail line only in the south, the "breadbasket" of the region. The Nyasaland Railways operate a steamer service on Lake Nyasa (Fig. 16), collecting and distributing some 9,000 tons of produce yearly, of which a large share is rice. A main road with a few feeders (Fig. 17) runs through the rest of the country, while a number of local roads converge on the marketing-processing complex of Blantyre-Limbe. In the cotton-harvesting season a steamer service operates on the lower Shire between Chiromo and Chikwawa. Two short extensions to the rail system, one to Lilongwe and one to Monkey Bay, are being considered by the railway administration.

Shipments from Nyasaland through Beira are entirely agricultural (cf. Table 4). In 1954, these exports totaled 74,349 short tons as compared with 31,781 tons in 1948. Fire-cured tobacco raised by Africans (some 33 million lbs. in 1954) and tea grown on European estates (Fig. 18) on the humid slopes of Mount Mlanje (6,500–7,500 tons a year) are normally by tonnage and value the main overseas Nyasaland exports through Beira. Cotton, the third ranking export, is marketed in Southern Rhodesia as well as abroad. In years of good harvests some maize moves to Beira, and groundnuts are now being pushed as a cash crop. Some hides and skins, including crocodile and game skins, are also exported via Beira. Tung oil exports, totaling only 900 tons in 1954, have not reached the importance hoped for in the early fifties partly because of the drastic fall in world prices after the Korean War.

FIG. 16. Nyasaland Railways steamer services on Lake Nyasa. Monkey Bay shipping point. (*Courtesy Federal Information Department.*)

Mineral deposits are known to exist in Nyasaland, some, like coal and bauxite, being rather extensive. But kyanite, of which 1,300 tons were shipped to the United Kingdom in 1954, is the only mineral now produced for export. Systematic evaluation is being made of pyrochlore and monazite deposits. Fishing in Lake Nyasa and forest exploitation in the south chiefly supply domestic needs, though there are limited shipments of tobacco-drum staves to the Rhodesias.

The flow to Nyasaland via Beira, totaling only 32,277 tons in 1948 and 64,273 short tons in 1954, is composed mainly of petroleum products (20–25,000 tons a year), cement, and general manufactured goods. The country produces practically all its food requirements. The small non-African population, 5,200 Europeans and 8,600 Asians in 1954, reduces the consumption of imported manufactured goods, and local manufacturing is limited to soap, cigarettes, and insecticides. The value of goods imported primarily for African consumption (some £2.5 million) did rise ten-fold between 1939 and 1953,[31] but is still low despite the considerable earnings brought home by the approximately one-third of able-bodied males who migrate each year for work to the Rhodesias and the Union.

The total goods tonnage carried on the Nyasaland Railways in 1954 was only 372,199 short tons, of which 90,000 tons were railway service traffic. This did represent a marked increase over prewar or early postwar years, requiring purchase of additional locomotives and rolling stock, but the major problem of the Nyasaland Railways has remained, not congestion as on the Rhodesia Railways, but inadequate traffic offering.[32] This has necessitated rather high rail rates which inevitably limit commodities moving to the seaboard to high-value, low-bulk items.

As long as the economy of Nyasaland is based on the existent type of agriculture it would be unrealistic to expect notable changes in traffic to and from the area via Beira. There are, however, certain developments that might greatly increase the trade of this territory. Implementation of the Shire Valley Scheme designed to regularize the level of Lake Nyasa,

[31] Nyasaland Protectorate, *An Outline of Agrarian Problems and Policy in Nyasaland* (Zomba, 1955).

[32] Nyasaland Railways Limited, *Director's Report and Accounts, Year Ended 31 December 1954*, p. 16.

FIG. 17. A local road in the northern section of Nyasaland feeding regional traffic to the main north-south highway and the southern rail head at Salima. (*Courtesy Federal Information Department.*)

reclaim and irrigate much of the Shire River lowlands, and provide large quantities of hydroelectric power, is an example.[33] Availability of power and improved transport might in turn stimulate the exploitation of known mineral deposits with a resulting increase in tonnage shipments from Nyasaland to Beira.

### BEIRA'S COMPETITORS AND BEIRA'S FUTURE

This paper has examined the historical development and the physical characteristics of Beira as a gateway together with the functions performed up to August 1955 by this Mozambique port in relation to its national and extranational tributary areas. At that date completion of the Limpopo Railway brought a new element to the traditional pattern of traffic flow to and from interior central Africa.[34] Thus far the most important withdrawals from Beira's outbound traffic have been some Northern Rhodesian copper shipments and the Southern Rhodesian asbestos fiber because of the proximity of asbestos mines to the Bannockburn terminal. Petalite exports from the Fort Victoria area are also destined to be moved via Lourenço Marques. Inbound traffic over the new railway has consisted at this early stage mainly of petroleum products and motor vehicles.

On the basis of export and import figures for 1954, if Northern Rhodesia ships one-half of the Copperbelt production out through Lourenço Marques and receives from it most of its imports, while Southern Rhodesia uses the southern Mozambique port for exporting all petalite and asbestos, and importing about

[33] Sir William Halcrow and Partners, *The Shire Valley Project—A Report on the Control and Development of Lake Nyasa and Shire River* (London, 1953).

[34] See discussion of the Rhodesian hinterland of Lourenço Marques in W. A. Hance and I. S. van Dongen, "Lourenço Marques . . .," *op. cit.*

FIG. 18. Tea is the second ranking overseas export of Nyasaland moving via Beira. An outstanding tea-raising area is found on the slopes of Mount Mlanje. (*Courtesy Federal Information Department.*)

one-third of its requirements, Beira may face in the next few years a total traffic loss of 0.8–0.9 million harbor tons.[35] But it is probable that an expansion in chrome ore mining held in check by the inadequacy of rail facilities to the seaboard and a general rise in exports from British Central Africa will mitigate the loss. Furthermore, chrome ore shipments from the Rhodesias will continue to pass over Beira's wharves because the Mozambique transport administration intends not to let the bulk chrome ore loading facilities at the port stand idle, even though the Selukwe mines would be interested in the new route. Any increase in Nyasaland overseas trade, either through prospective mineral exploitation or through a rise in agricultural output foreseen in the Shire Valley Development Scheme will also benefit Beira only. The "Sinoia-Kafue cut-off," almost certain to be constructed relatively soon,[36] is likely to rejuvenate the appeal of Beira to the Copperbelt by offering a greatly shortened route to that port.

Whatever may be the compensations, a prospective loss of one quarter of the present port traffic has greatly alarmed Beira, whose community is inclined to look somewhat bitterly at the gains of Lourenço Marques. They feel there is little they can do to prevent a reduction in their income because Lourenço Marques is the capital city from which all transport policies in Mozambique are issued, with the approval of Lisbon. But a temporary reduction in traffic will have the advantages of permitting a more rational use of port facilities, repair

[35] Forecasts of traffic gains by Lourenço Marques as they were made in Table 20, of Knappen-Tippets-Abbett report (*op. cit.*) appear to be rather high. It is unlikely, for example, that Belgian Congo trade will be re-routed to Lourenço Marques because of existing shipping arrangements at Beira.

[36] The need to deliver construction supplies for the great Kariba Gorge hydroelectric plant makes immediate construction of a portion of this route highly desirable.

of Beira's outworn equipment, and better development plans for the terminal's future. And, if the vigorous growth of the Federation is sustained, the facilities of the port should be fully utilized again in a few years.

Pending some stabilization of British Central African traffic along the three possible routes to the East and South—via Beira, the Union ports, or the new Lourenço Marques line—regional transport interests have shown little desire to consider other potential outlets. A route to the West, however, has been insistently demanded in the Federation, notably by the Northern Rhodesian Chamber of Mines. The latter naturally has been attracted by the shorter rail and sea distances to chief consuming centers in Western Europe and North America offered via the existing Lobito gateway on the Atlantic seaboard. It has also noted that the development of the Lobito route at this time would constitute welcome insurance of an unhampered flow of strategic materials to the Free World in the event of another war.

In November 1956, the Copperbelt producers were finally partially released from commitments to use the Rhodesia Railways and Mozambique ports. A maximum of 20 percent of their total copper production may now be exported via Lobito. As a 1957 increase in rates for copper shipments on the Rhodesian Railways has brought them into parity with those of the western route, previously more expensive, a further incentive is created to employ the route to Lobito insofar as possible. Overseas imports for Northern Rhodesia are also permitted to move via Lobito for a period of four years from January 1957.[37]

The position of Angola on the Atlantic Ocean, comparable to that of Mozambique on the Indian Ocean, has further spurred Portuguese West Africa to undertake several rail extensions which might eventually be linked with the Rhodesian rail system. One is the lengthening of the southern Angolan line from Moçâmedes, which is being improved as a deepwater port. This line now reaches Vila Serpa Pinto and may be extended toward Livingstone or Broken Hill within the next few years. Baía dos Tigres (Tiger Bay) might serve as a supplementary ocean terminal for this railroad. Other proposals include extending the rail from Luanda to the Benguela line,[38] and effecting a direct link from the Benguela Railway to the Rhodesia Railways, bypassing the existent line through the Belgian Congo.

Other territories adjacent to British Central Africa have also planned railways to this rapidly developing and landlocked area. In 1948–49, East African Railways proposed a connection from Dar es Salaam through the northeastern lobe of Northern Rhodesia to the existent Rhodesian mainline, near Broken Hill. This scheme was shelved because of high rail construction costs and uncertainty regarding the feeding capacity of the poorly developed area through which it would pass.[39] A second example is the line from Nacala in northern Mozambique which now extends to Nova Freixo and is being carried to Lake Nyasa where it might serve as a second outlet for Nyasaland and adjacent parts of Northern Rhodesia.[40]

The Union of South Africa rail and port transport organization has also long bid for Central African trade. Since the beginning of the century it has endeavored to bring pressure upon the Rhodesias for a greater use of South African ports and, when the decision was reached to construct the Bannockburn-Guijá link instead of an expected West Nicholson-Beitbridge junction, there was bitter disappointment in South African transport circles. Previously, the South African Railways had fought strongly against the emergence of the Lobito-Benguela Railway route,[41] and at the Johannesburg Conference it was the S. A. R. which led the move to impose a system of extremely unfavorable freight tariffs on the

[37] *Tripartite Agreement between the Companhia do Caminho de Ferro de Benguela, the Compagnie du Chemin de Fer du Bas-Congo au Katanga and the Rhodesia Railways relating to the passage of goods traffic between Lobito and the Rhodesia Railways* (Bulawayo, November 1956). Mimeographed.

[38] W. A. Hance and I. S. van Dongen, "Port Development and Rail Lines in Portuguese West Africa," *XVIIIth International Geographical Congress* (Rio de Janeiro, 1956).

[39] I. S. van Dongen, *The British East African Transport Complex*, University of Chicago, Geography Research Monograph No. 38 (1954), pp. 149–54.

[40] I. S. van Dongen, "Nacala, Newest Mozambique Gateway to Interior Africa," *Tijdschrift voor Economische en Sociale Geografie*, 48th year (Rotterdam, 1957), pp. 65–73.

[41] A. A. Lisboa de Lima, "Angola e Moçambique e as correntes de trafego maritimo africano ao sul de Equator," *Boletim da Sociedade de Geografia de Lisboa*, Série 45a (1927), pp. 250–61.

Benguela Railway Company—Chemin de Fer du Bas Congo au Katanga (B.C.K.) rail combination. Shippers over the 1,450-mile section from Sakania on the Congo border to Lobito were charged up to 1957 the same rates as existed on the 2,600-mile route from Sakania to Port Elizabeth or Durban.

A recent Union offer is to make available to the Federation a means of egress via South West Africa to Walvis Bay. For the time being the South African Railways have committed themselves only to an improvement of existing rail trackage from the port to Tsumeb or Gobabis. A group of British promoters, however, formed a company to construct a rail junction between either of these points and the Rhodesian main trunk in the vicinity of Wankie. But efforts to attract capital were unsuccessful and they switched in 1955-56 to proposing the opening of this route by "LeTourneau" off-road transporter equipment such as has been used in constructing U. S. military bases in remote Canadian areas.[42]

In the face of such competition for Central African trade the position of Beira as the master gateway to British Central Africa is likely to undergo many changes in the future. Its location nearest some of the most productive parts of the Federation, however, is likely to assure its continuing importance. And if the Federation economy continues to grow as it has in the past decade, whatever loss may occur from the new Lourenço Marques line should soon be more than met by expanded traffic offering.

[42] Barclays Bank: *Overseas Review* (October 1955), p. 26.

# SOME NEW MAPS OF THE UNDERGROUND BITUMINOUS COAL MINING INDUSTRY OF PENNSYLVANIA[1]

GEORGE F. DEASY AND PHYLLIS R. GRIESS

*The Pennsylvania State University*

THE outstanding status of the bituminous coal mining industry of the Appalachian Plateau would not be suspected from the meager treatment accorded the subject in geographical literature. True, a number of excellent articles have dealt with specific facets of the subject,[2] but no attempt has been made to present a thorough study of the topic, even for a portion of the coal-producing area.

The only moderately adequate geographical treatment of bituminous coal mining in eastern United States is found in a textbook on North America written by British rather than American authors.[3] But the industry is discussed as it existed some twenty to thirty years ago, and many facets of the industry are omitted. For the Pennsylvania portion of the Appalachian Plateau, by far the most comprehensive geographical analysis of bituminous coal mining is contained in a textbook on that state written by the Murphys.[4] This book, however, was published almost twenty years ago, and hence much of the information is out of date; and maps dealing with the industry are few in number.

Most modern American textbooks on the

[1] Field and library work upon which this study is based were supported by a grant from the Mineral Conservation Section of the College of Mineral Industries, The Pennsylvania State University.

[2] E. W. Miller, "Connellsville Beehive Coke Region —A Declining Mineral Economy," *Economic Geography*, Vol. 29 (1953), pp. 144–58; R. E. Murphy and H. E. Spittal, "A New Production Map of the Appalachian Bituminous Coal Region," *Annals*, Association of American Geographers, Vol. 34 (1944), pp. 164–72, and "Movements of the Center of Coal Mining in the Appalachian Plateaus," *Geographical Review*, Vol. 35 (1945), pp. 624–33.

[3] L. R. Jones and P. W. Bryan, *North America* (New York: Dutton, 1950).

[4] R. E. Murphy and M. Murphy, *Pennsylvania: A Regional Geography* (Harrisburg: The Pennsylvania Book Service, 1937).

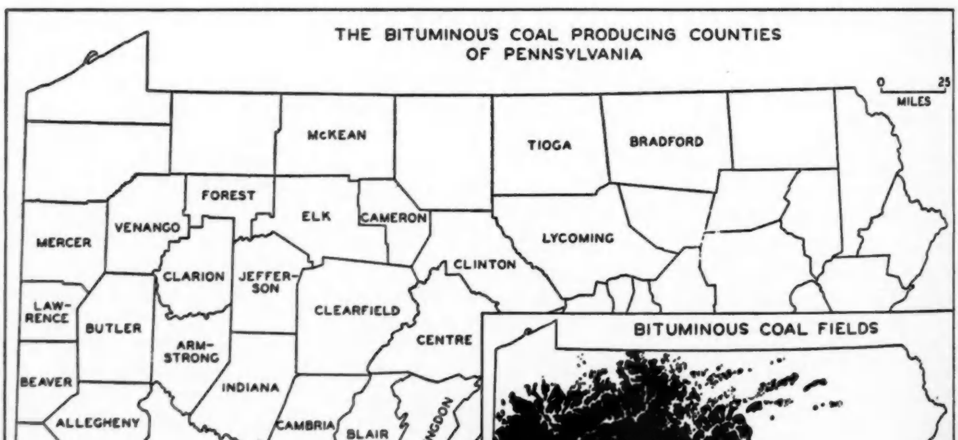


FIG. 1. Bituminous coal producing counties of Pennsylvania. Inset map shows areas underlain by one or more coal seams. Data from Pennsylvania Bureau of Topographic and Geologic Survey.

geography of North America or on economic geography devote at most a few pages, and usually only a few columns, to the Appalachian bituminous coal industry; and much of this material is concerned, not with the *production* of coal, but with its geological origin, its chemical and physical characteristics, its marketing, and its industrial utilization. Typically, the information concerning coal mining *per se* is brief, generalized, vague, and incomplete; or it is out of date, and not infrequently even misleading or incorrect. For instance, little or no specific information is given as to the number and location of mines, or mine output and mine employment. Materials are generally lacking on such topics as seams currently being mined, and the degree to which individual seams have been mined out. No modern data are presented on types of mine entries, or on depths of mine shafts. There is some good geography connected with these and related topics, and such topics should form the core of an analysis of the Appalachian coal *mining* industry by geographers.

It is the purpose of this article to remedy a portion of what the authors believe is a deficiency in American geographical literature, by presenting a series of detailed maps concerning neglected facets of the underground coal mining industry of western Pennsylvania (Figs. 1 and 2).[5] Figures 3 to 10 are divided into three groups and are analyzed on this basis. The first group is concerned with certain geologic aspects of the coal mining industry. The second group deals with a number of

[5] Major sources of data for preparation of the maps are as follows:

(1) Unpublished manuscript maps prepared at irregular and generally widely spaced intervals by the Pennsylvania Department of Mines showing the names and locations of all active underground bituminous coal mines in the state at a particular date. The latest such map is dated September 1, 1954.

(2) *Annual Reports* of the Bituminous Division of the Pennsylvania Department of Mines, which tabulate certain geologic, engineering, and economic information about all bituminous coal mines which employ at least 5 persons underground and which were operative in the state during at least a portion of the year.

(3) *Reports of Investigations* issued during recent years by the U.S. Bureau of Mines, which deal with mined-out areas and with estimates of known recoverable reserves of coking coal in certain bituminous coal producing counties of western Pennsylvania.

(4) The various publications and maps on the bituminous coal and geology of Pennsylvania issued from time to time by the Pennsylvania Bureau of Topographic and Geologic Survey.

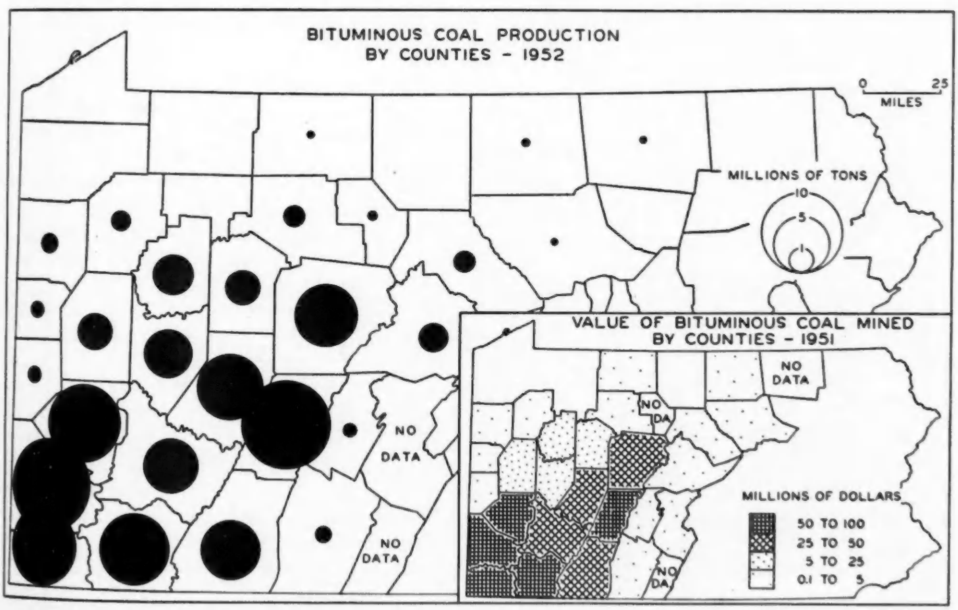


FIG. 2. Bituminous coal production in Pennsylvania, by counties, 1952. The output from both underground and strip mines is included, with the former accounting for more than three-fourths of the production. Inset map refers to value of coal at the mine. Data from U. S. Bureau of Mines.

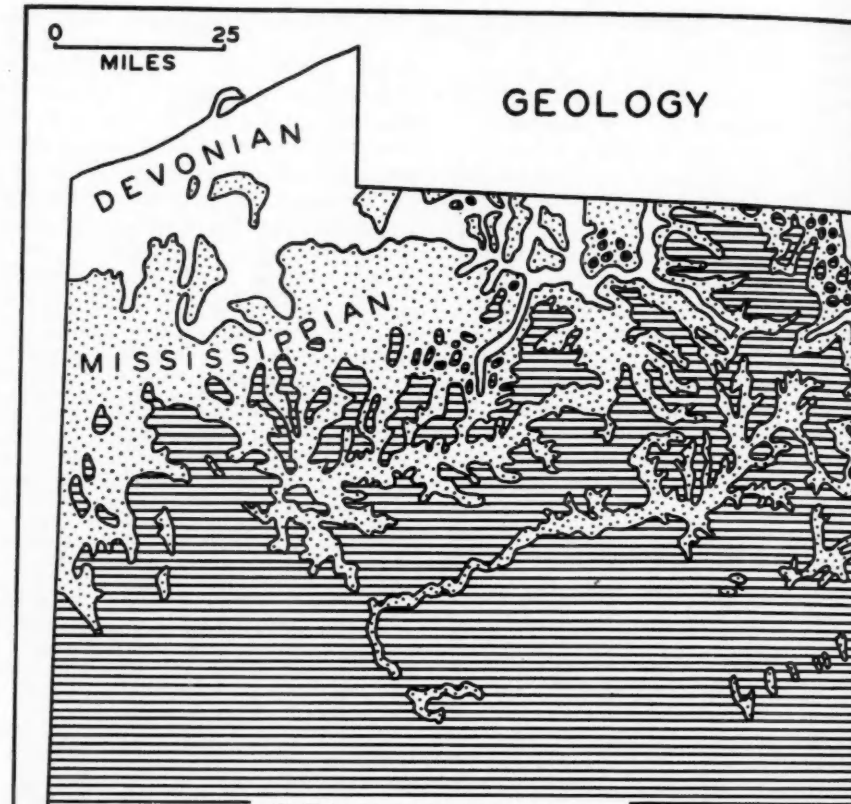


FIG. 3. Geologic map of western Pennsylvania. Data from Pennsylvania Bureau of Topographic and Geologic Survey.

engineering aspects that are of significance to the geographer. The third series of maps presents economic aspects of soft coal mining in western Pennsylvania.

### GEOLOGIC ASPECTS

Most of western Pennsylvania, except for a narrow strip along Lake Erie, consists of the dissected Appalachian Plateau. Elevations generally range from 1,000 to 3,000 feet, and local relief varies from 200 to almost 2,000 feet.

Typically, both elevation and relief increase southeastward, away from the shore of Lake Erie. Structurally, however, the relatively unfolded and unfaulted strata that underlie the plateau dip gently southwestward, so that the youngest surface strata of the area (Permian) are confined to the southwestern corner of the state, while progressively older rocks (Pennsylvanian, Mississippian, and Devonian) outcrop at the plateau surface farther northward and eastward (Fig. 3). A number of secondary features disturb the symmetry of this broad pattern. Three sharp but decapitated anticlinal ridges in the southeastern part of the plateau bring Mississippian strata to the plateau surface in an area otherwise consisting of Pennsylvanian rocks; and incised stream valleys permit long fingers and isolated outliers of rocks of various ages to interpenetrate one another (Fig. 3).

More than 60 coal beds are incorporated within the Pennsylvanian and Permian rock strata of western Pennsylvania.[6] The entire sequence is not found at any one site for many of the beds have only limited horizontal extent. Some beds, however, extend beneath major portions of the Appalachian Plateau in Pennsylvania, and continue westward and southward into neighboring Ohio and West Virginia. In general, the number of coal seams is greatest in the southwestern counties (from 25 to 34 seams per county), where the entire stratigraphic sequence of coal-bearing rocks from the basal Pennsylvanian up through the lower Permian is present. The number of coal seams gradually decreases northward and eastward as successively older strata outcrop at the surface, until in the northernmost and easternmost coal-producing counties only a few of the older seams of Pennsylvanian age remain. It is evident, therefore, that almost everywhere within the bituminous coal producing counties of Pennsylvania there are available one or several coal seams that either outcrop on the sides of stream valleys or lie at shallow depths beneath the interfluves. As a correlative to this statement, different coal seams will outcrop or lie near the surface in different areas. Other seams in each such area either will be deeply buried or will have been removed by erosion. Hence, a regionalized pattern of accessible coal seams characterizes the area.

When one examines the underground bituminous coal mining industry of Pennsylvania in the light of what has been said above, some interesting distributional patterns become evident. Six coal seams are of primary importance in terms of production today: Pittsburgh, Upper and Lower Freeport, and Upper, Middle, and Lower Kittanning. Mines utilizing the Pittsburgh seam, stratigraphically highest of the six, are localized in a relatively restricted zone in the southwest (Fig. 4). Greene County has 17 Pittsburgh-seam mines, Washington has 24, Allegheny 21, Fayette 37, Westmoreland 33, Armstrong 8, Indiana 1, and Somerset 2. Furthermore, there is a western, as well as a northern and an eastern, border to the area in which the seam is being mined (Fig. 4), the western border coinciding essentially with the margin of the area in which the Pittsburgh seam is deeply buried (as much as 1,000 feet in places).

Mines utilizing the stratigraphically lower Freeport seams are located in general to the north and east of mines utilizing the Pittsburgh seam (Fig. 4). For example, three of the southwestern counties in which the Pittsburgh seam is heavily utilized (Greene, Washington, and Fayette) have no mines in the Freeport coals. On the other hand, mines employing the Freeport seams are located in eight counties that have no Pittsburgh seam mines. An intermediate group of four counties (Allegheny, Westmoreland, Armstrong, and Indiana) in part constitutes a zone of overlap wherein both Pittsburgh and Freeport coals are mined.

Finally, mines utilizing the stratigraphically even lower Kittanning coal seams are concentrated primarily in belts that lie to the north

[6] G. H. Ashley, *A Syllabus of Pennsylvania Geology and Mineral Resources*, Pennsylvania Topographic and Geologic Survey, Bull. G–1 (Harrisburg, 1931), p. 92.

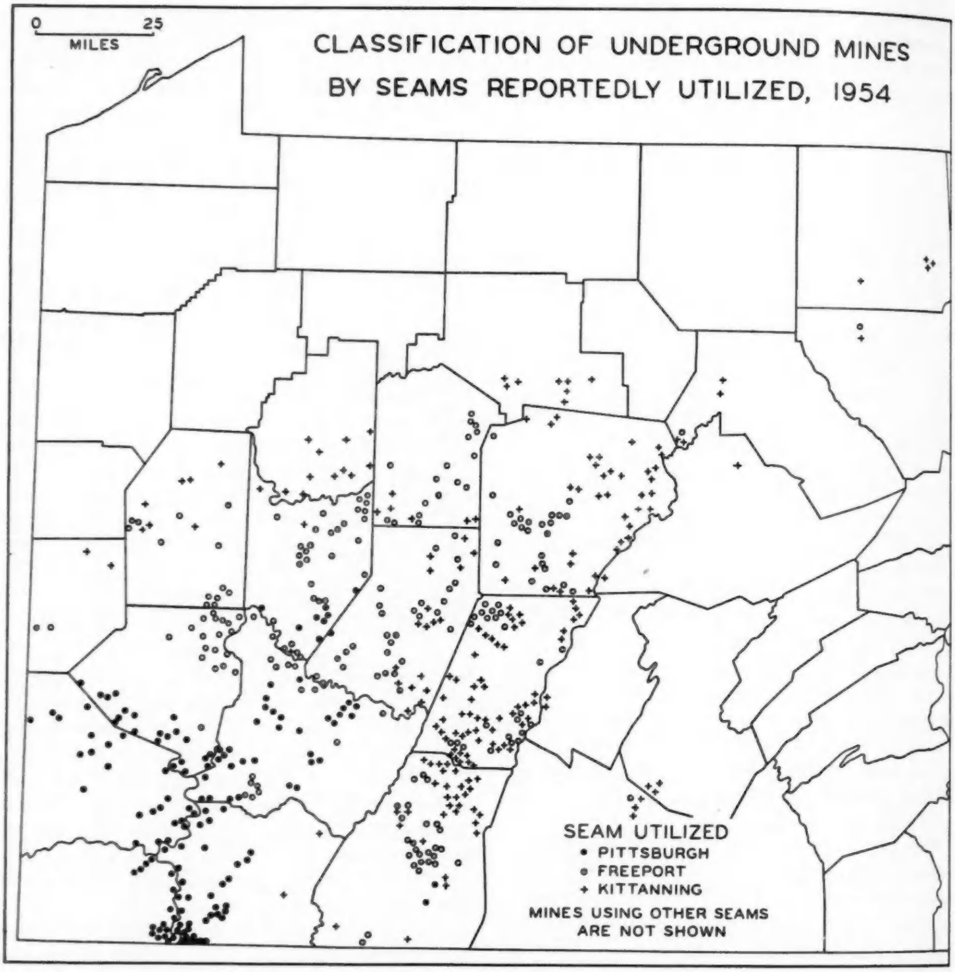


FIG. 4. Classification of underground bituminous coal mines in Pennsylvania by seams reportedly utilized, 1954. Only mines employing five or more persons underground are shown. No data are available for a number of mines. Data from Pennsylvania Department of Mines.

and east of areas tapping the Freeport beds (Fig. 4). In connection with Figure 4, it should be noted that Pittsburgh seam mines are fewer in number (143) than those employing either the Freeport seams (211) or the Kittanning seams (203).

## ENGINEERING ASPECTS

Two major problems face the potential miner of coal: (1) getting to the coal seam and (2) extracting the coal from the seam. Solution of the first depends in large measure upon the position of the coal bed with reference to the land surface. Does the seam outcrop? Is it shallowly buried? Or is it deeply buried? The type of entry made into the coal bed is dependent upon the answer to these questions.

Solution of the second problem hinges primarily upon characteristics of the seam itself. Is it horizontal, or essentially so, or does it dip steeply? Is it continuous, or is it offset by faults? Is the bed thick or thin? Does it have a strong or a weak roof? These and other less

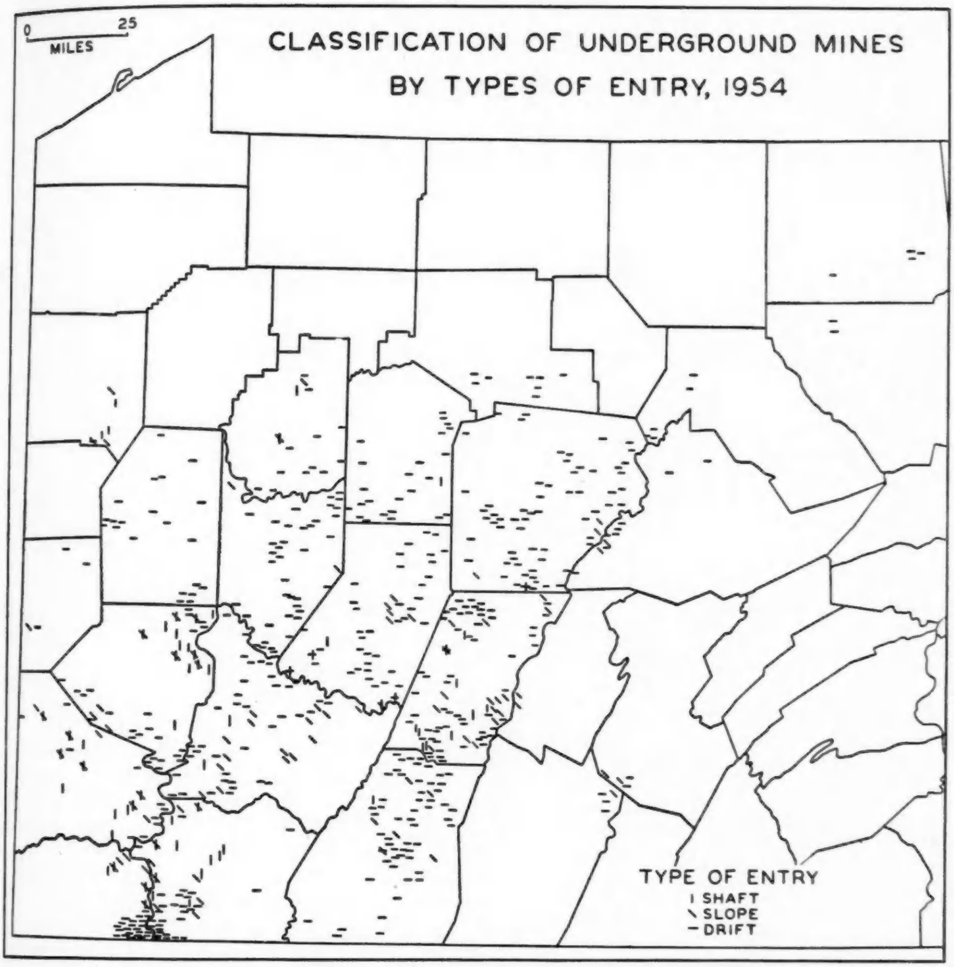


FIG. 5. Classification of underground bituminous coal mines in Pennsylvania by types of entry, 1954. Only mines employing five or more persons underground are shown. No data are available for a number of mines. Where there is more than one type of entry to a mine, map symbols are crossed. Data from Pennsylvania Department of Mines.

important factors largely determine the ease or difficulty of coal extraction.

Although data are unobtainable to permit the preparation of maps concerning all of the above topics, sufficient information is at hand to deal with certain of these matters. There is a potential geographic aspect to all of the above topics, for spatial variations in each would either assist or handicap the individual extractor of coal.

*Mine Entries*

The outcropping and essentially flat-lying coal beds of the northern Appalachian region permit the use of horizontal, or nearly horizontal, mine entries termed "drifts" which permit ready access to the seams. In fact, the area has become a type region in the literature to exemplify drift mining.

Slope and shaft entries, however, are by no means rare today. As Figure 5 illustrates,

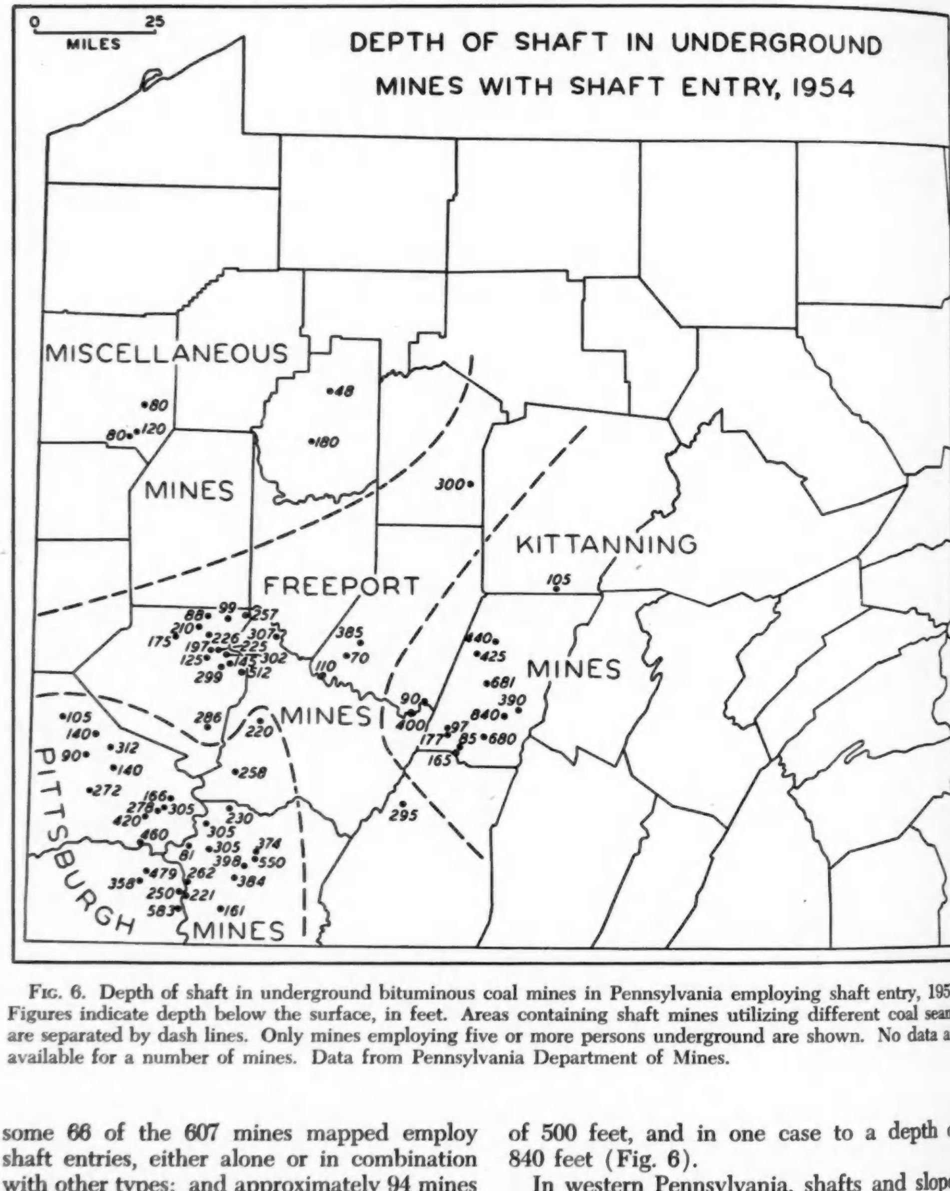


FIG. 6. Depth of shaft in underground bituminous coal mines in Pennsylvania employing shaft entry, 1954. Figures indicate depth below the surface, in feet. Areas containing shaft mines utilizing different coal seams are separated by dash lines. Only mines employing five or more persons underground are shown. No data are available for a number of mines. Data from Pennsylvania Department of Mines.

some 66 of the 607 mines mapped employ shaft entries, either alone or in combination with other types; and approximately 94 mines utilize slope entries, either alone or in combination. Shafts and slopes are employed to mine not only the much-sought-after Pittsburgh seam, but also the Freeport, Kittanning, and other less important seams (Fig. 6); and shafts extend much farther beneath the surface in this region than is commonly realized —in a number of instances to depths in excess of 500 feet, and in one case to a depth of 840 feet (Fig. 6).

In western Pennsylvania, shafts and slopes are utilized primarily to obtain the more heavily capped remnants of a particularly desirable seam in areas where valley outcrops already have been worked out; or they are employed along the southwestern margin of the exploited portion of a seam, where it no longer outcrops but instead begins to dip deeply beneath overlying strata. Because of the lat-

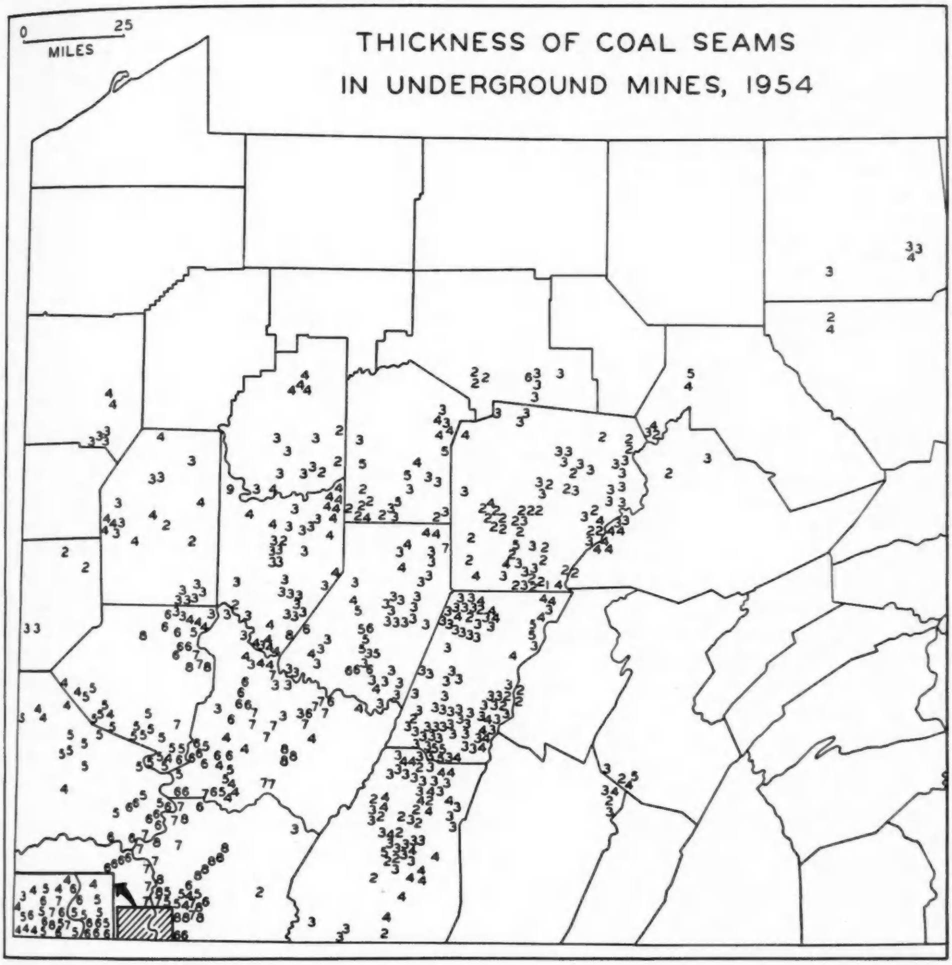


FIG. 7. Thickness of seams utilized in underground bituminous coal mines in Pennsylvania, 1954. Figures represent the following: 1 = 1 foot to 1 foot 11 inches, 2 = 2 feet to 2 feet 11 inches, and so on. Only mines employing five or more persons underground are shown. No data are available for a number of mines. Data from Pennsylvania Department of Mines.

ter situation, few shaft and slope mines are found in the northern half of the coal producing area (Fig. 5).

### *Seam Thicknesses*

With regard to extracting coal once a seam has been entered, a number of characteristics of the coal bed itself are of significance. Since all seams in the Pennsylvanian portion of the Appalachian Plateau are essentially horizontal over most of their extent (dip less than 5°),[7] are almost unaffected by faulting, and have relatively strong roofs, the major factor producing areal variations in ease or difficulty of mining is difference in the thickness of seams.

Pennsylvania's bituminous coal seams differ from one another considerably in thickness. Some average 6 or more feet thick; others average only an inch or so. Moreover, except for the Pittsburgh seam, which is characterized by relative uniformity of thickness over essentially its entire extent in Pennsylvania, even the major seams are highly variable in

[7] *Ibid.*, p. 95.

thickness, often ranging from many feet to less than a foot over relatively short distances. A map was prepared, on a mine by mine basis, to show the thickness of the coal seams within all underground bituminous mines currently operating in western Pennsylvania (Fig. 7). This map reveals marked areal variations in the thickness of seams being utilized.

Mines employing coal seams with a height of from 6 to over 9 feet number only 110 out of a total of 607, and they are limited almost exclusively to a small area in the southwestern corner of the state—chiefly parts of Greene, Washington, Allegheny, Fayette, and Westmoreland counties (Fig. 7). Comparison of the map showing thick-seam mines with an earlier map representing mines utilizing the Pittsburgh seam (Fig. 4) indicates a close but not perfect correlation between the two. Of the 143 Pittsburgh-seam mines, 88 are operating where the seam is 6 feet or more in height. Or, stated in another fashion, of the 110 thick-seam mines, 88 are operating in the Pittsburgh seam.

Mines operating in seams ranging from 4 feet to 5 feet 11 inches in height are more numerous (188) than the thick-seam mines (Fig. 7). Although locally present where thick-seam mines are operating, medium-seam mines tend to be found mainly in areas farther to the north and east. In general, medium-seam mines are found operating chiefly in the Freeport beds (Figs. 4 and 7).

Mines utilizing seams ranging from 2 feet to 3 feet 11 inches in height are the most numerous of all (Fig. 7), numbering 309 or over one-half of the total of 607 mines. Their distribution is exceedingly widespread, although in general such thin-seam mines tend to be found even farther to the north and east than the medium-seam mines. Most of the thin-seam mines are operating in the several Kittanning beds, but a fairly large number are utilizing the Freeport beds (Figs. 4 and 7).

## ECONOMIC ASPECTS

Certain economic aspects of the underground bituminous coal mining industry of the Appalachian Plateau merit more comprehensive treatment than they have received thus far in geographical literature. Among the topics for which information is available on the Pennsylvanian portion of the area are the following: (1) tonnage output of individual mines, (2) employment in individual mines, (3) tonnage output by individual seams, and (4) depletion of coal resources and remaining reserves.

### *Mine Output*

The current situation with regard to underground bituminous coal production in western Pennsylvania, on a mine-by-mine basis, is presented in Figure 8, and a number of important facts become evident. For one, the coal industry of the area is seen to be organized chiefly around numerous small-scale producers. Of the 607 mines, only 5 have an annual output in excess of one million tons, and only 26 yield between one-half and one million tons.[8] Sixty-four mines each yield from one-tenth to one-half million tons. All of the remaining 512 mines have yields of less than 100,000 tons a year; i.e., their daily output is on the average only a few tens to a few hundreds of tons.[9] Such a development has been fostered by the almost unlimited number of sites at which the virtually omnipresent coal seams could be attacked, and by the ease with which the outcropping coal could be mined by small companies or even individuals with a minimum of capital and equipment. However, much of the chaotic competition that characterizes the coal industry of the area stems from this situation, for "as a general rule companies have mined as much coal as they could as fast as they could and have poured this production on the market with little idea of where and how they were going to sell it. As a result, the market has been continually depressed and only a few companies have made much money."[10]

Another fact of importance is evident on the map in Figure 8—namely the concentration of virtually all of the large- and medium-scale mines in the southern half of the coal producing area. Mines yielding over a million tons annually are limited to four of the 29 coal producing counties (Greene—1, Washington — 2, Fayette — 1, and Indiana — 1);

[8] Maximum production from a single mine in 1954 was somewhat over 4,000,000 tons.

[9] These figures exclude mines employing fewer than 5 persons underground. Such mines number in the hundreds but produce only some 2 to 3 percent of the deep-mined coal of the area.

[10] W. M. Aikman and others, *The Coal Industry: Its Problems and Prospects* (Huntington, W. Va.: Princess Coal Sales Co., 1952), p. 47.

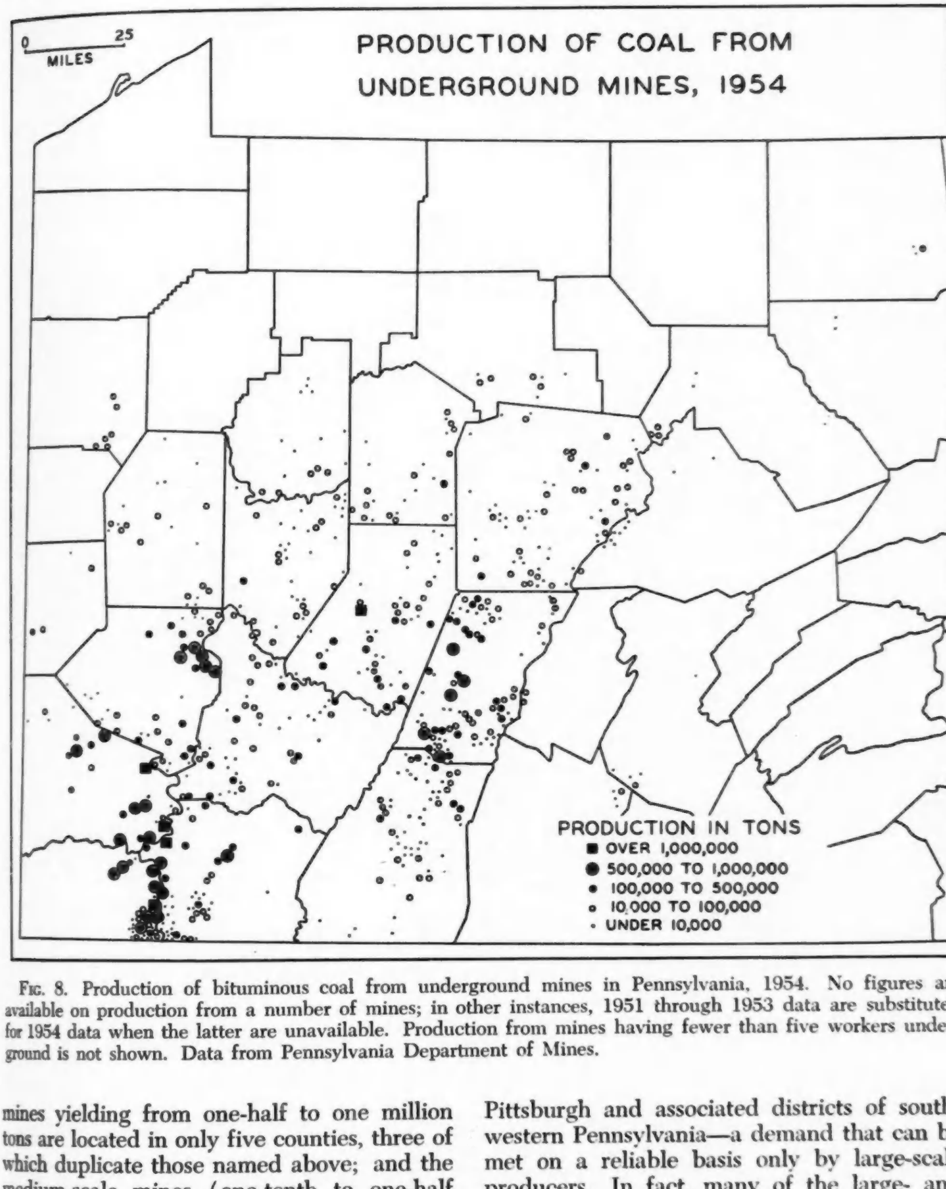


FIG. 8. Production of bituminous coal from underground mines in Pennsylvania, 1954. No figures are available on production from a number of mines; in other instances, 1951 through 1953 data are substituted for 1954 data when the latter are unavailable. Production from mines having fewer than five workers underground is not shown. Data from Pennsylvania Department of Mines.

mines yielding from one-half to one million tons are located in only five counties, three of which duplicate those named above; and the medium-scale mines (one-tenth to one-half million tons) are restricted to eleven counties. Elsewhere in western Pennsylvania the underground coal mining industry is conducted exclusively on a small-scale basis. Concentration of the larger mines in the southern half of the coal-producing area is largely a result of the demand for great quantities of uniform quality coal by the industrial complexes of the Pittsburgh and associated districts of southwestern Pennsylvania—a demand that can be met on a reliable basis only by large-scale producers. In fact, many of the large- and medium-scale mines are so-called "captive mines," owned and operated by such large coal-consuming firms as iron and steel companies and public utilities.[11]

[11] Among these are Bethlehem Steel Corp., Crucible Steel Company of America, Duquesne Light Co., Jones and Laughlin Steel Corp., Republic Steel Corp., and United States Steel Corp.

Comparison of Figures 4 and 8 shows that there is little relationship between large- and medium-scale mines and the various coal seams. Such mines tap Pittsburgh, Freeport, and Kittanning seams alike, since coal from all such major seams has properties suitable for a variety of important industrial purposes.

Comparison of Figures 5 and 8, however, reveals that a preponderance but by no means all of the large- and medium-scale mines employ shaft or slope entries rather than drifts. Coal tonnages removed by large-scale operations are so great, and areas exhausted of coal become so extensive, that after a number of years it no longer is economical to haul the mined coal long distances underground to the original drift entries along the valley sides. Hence, shaft or slope entries are driven to the seams at sites in closer proximity to the places where they are being worked.

Comparison of Figures 7 and 8 indicates that large- and medium-scale mines tend to utilize seams more than four feet thick. The economies inherent in mining the thicker seams account for this preference by the larger operating companies.

### *Mine Employment*

A map showing employment in underground bituminous coal mines, on a mine-by-mine basis, would exhibit a pattern closely resembling that on the previous map showing mine output, and hence is not included in this paper. Only 2 mines have 1,000 or more employees;[12] 23 have from 500 to 999 employees; 80 employ from 100 to 499. The remaining 502 mines all have from 5 to 99 employees, and a majority of these have fewer than 25 employees.[13] Hence, most coal mining operations in western Pennsylvania are on a small scale in terms of employment as well as output. Moreover, mines employing large numbers of people (over 100) are concentrated in the southern half of the coal-producing area in a pattern almost, but not quite, identical with that of the coal output map.

### *Seam Output*

The bituminous coal mining industry of Pennsylvania has been dominated from its inception by the Pittsburgh seam—the highest quality, most easily mined, and most strategically located coal bed in the state. From 1759, the earliest known year in which coal was mined in the state, until 1804, the total bituminous coal output was derived from this single seam; and until nearly the end of the 19th century it typically supplied some two-thirds or more of the output. Since 1940, however, less than one-half of Pennsylvania's bituminous coal has come from the Pittsburgh seam (Table 1), and there has been a corresponding increase in importance of the Freeport and Kittanning seams.

The absolute and relative decline of the Pittsburgh seam has not been due to depletion of its reserves, for considerably more Pittsburgh coal remains underground than thus far has been mined; nor has it been the result of a radical change in thickness of seam or quality of coal as the bed has been penetrated, since the seam is remarkably constant in these characteristics over its entire extent in Pennsylvania. Instead, the dwindling significance of the seam can be traced back to

TABLE 1.—ESTIMATED PRODUCTION FROM THE PITTSBURGH SEAM IN PENNSYLVANIA, AND THE PERCENTAGE OF TOTAL BITUMINOUS PRODUCTION DERIVED FROM THE SEAM, 1759–1950[1]

| Year | Production from Pittsburgh seam (net tons) | Percentage of total bituminous production |
|---|---|---|
| 1759 | 50 | 100 |
| 1770 | 100 | 100 |
| 1780 | 400 | 100 |
| 1790 | 30,000 | 100 |
| 1800 | 87,000 | 100 |
| 1810 | 120,000 | 98 |
| 1820 | 200,000 | 95 |
| 1830 | 300,000 | 94 |
| 1840 | 410,093 | 88 |
| 1850 | 1,317,000 | 92 |
| 1860 | 2,380,460 | 88 |
| 1870 | 4,613,625 | 59 |
| 1880 | 11,809,516 | 65 |
| 1890 | — | — |
| 1900 | — | — |
| 1913 | 101,757,000 | 59 |
| 1920 | 87,102,000 | 52 |
| 1930 | 67,898,000 | 55 |
| 1940 | 59,727,000 | 54 |
| 1950 | 42,098,000 | 41 |

[1] *Sources:* From 1759 to 1880, H. N. Eavenson, *The Pittsburgh Coal Bed: Its Early History and Development* (New York: The American Institute of Mining and Metallurgical Engineers, 1938). From 1913 to 1950, personal letter dated Dec. 21, 1956, from Mr. R. T. Laing, Executive Director of the Central Pennsylvania Coal Producers' Association, Altoona, Pa. No data were located for the years 1890 and 1900.

[12] The maximum number of employees for a single mine in 1954 was 2,981.

[13] These figures exclude mines employing fewer than 5 persons underground, which number in the hundreds.

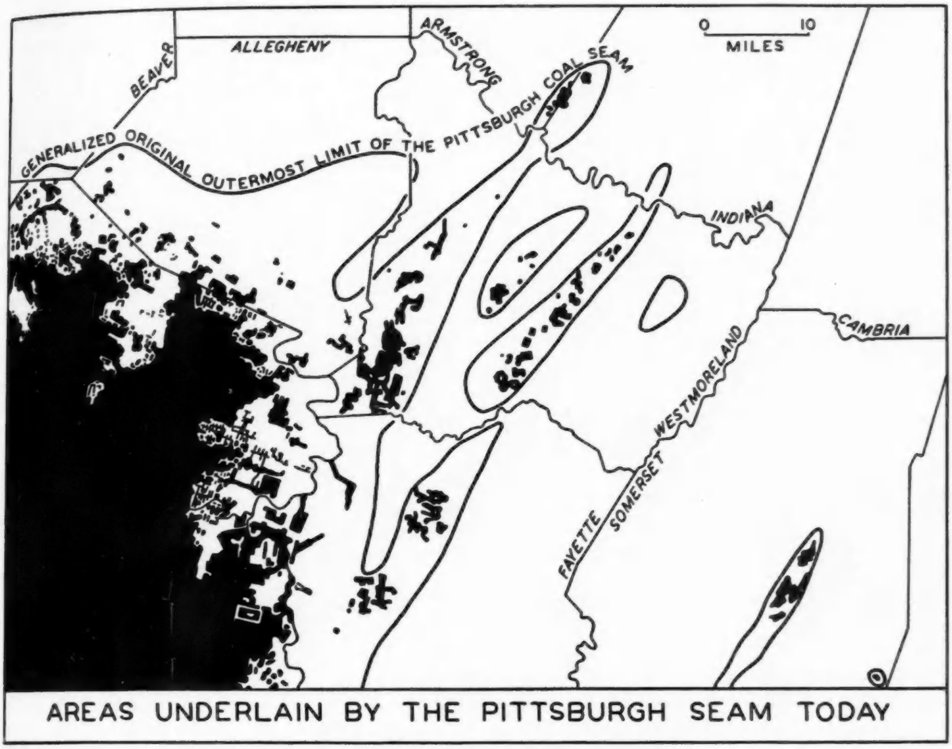


FIG. 9. Areas underlain by the Pittsburgh coal seam today. Areas still possessing Pittsburgh coal are represented in black. Some mined-out sections (white areas within the lines representing the original limits of the Pittsburgh seam) still have small quantities of Pittsburgh coal remaining, which will continue to yield from small-scale mining operations. Individual county surveys upon which the above map is based were made at intervals between December 1950 and August 1955. Data from U. S. Bureau of Mines.

the geological structure of western Pennsylvania that was described earlier in this paper. Initial mining operations logically attacked the seam via drift entries where it was exposed—particularly in Allegheny, Westmoreland, Fayette, northeast Washington, and eastern Greene counties—and left untouched those portions of the bed that were deeply buried in southern Washington and most of Greene counties.[14] Today, almost all of the readily accessible portions of the Pittsburgh seam have been mined out (Fig. 9). Many of the present mines tapping the seam must use shaft or slope entries (compare Figs. 5 and 9). Future such mines in southern Washington and most of Greene counties will have to be almost entirely of this nature—a factor that will increase the cost of mining Pittsburgh-seam coal even more than at present. This will shift the production balance still further in favor of mines utilizing the almost untapped resources of the Freeport and Kittanning seams which, though generally thinner, nevertheless still outcrop in many places.

### *Depletion and Reserves*

The above information on the Pittsburgh coal seam logically raises a question concerning the total coal reserves of Pennsylvania, and the extent to which they have been depleted. The topic is especially relevant when one realizes that over one-quarter of the bitu-

[14] The Pittsburgh seam lies more than 1,000 feet below the surface in parts of Greene and Washington counties. See G. H. Ashley, *Bituminous Coal Fields of Pennsylvania: Part I, General Information on Coal*, Pennsylvania Topographic and Geologic Survey, Bulletin M6 (Harrisburg, 1928), pp. 143 and 150.

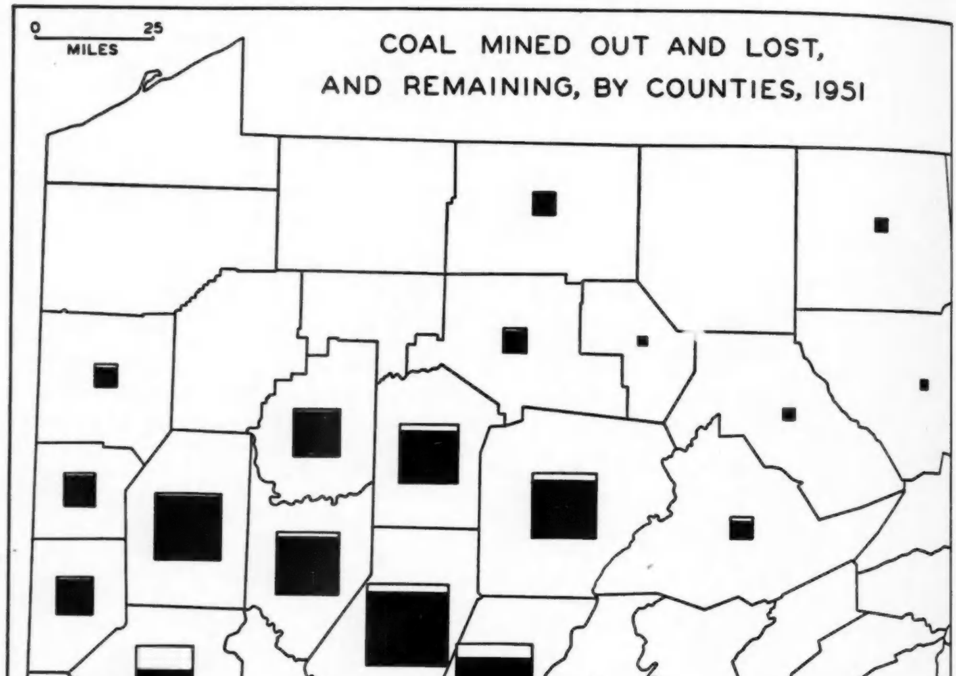


FIG. 10. Estimate of bituminous coal mined out and lost, and remaining, in Pennsylvania, by counties, 1951. Data upon which this map is based include seams with a thickness of as little as 1 foot, and of a grade or geologic character that would not permit economical extraction at the present time. Of the coal that remains in each county, approximately 40 to 50 percent will be lost in mining and processing. Hence, the effective reserves constitute only 50 to 60 percent of the quantities shown. No data were available for Forest and Venango counties, and Bradford County is not shown on the map; but in each of these the reserves would be very small. Data from Pennsylvania Bureau of Topographic and Geologic Survey.

minous coal produced in the United States since the beginning of mining has come from this state.

A number of estimates, based on different assumptions and having differing degrees of reliability, have been made of Pennsylvania's bituminous coal resources. As early as 1881, H. M. Chance calculated the original reserves at 33,844,200,000 net tons.[15] In 1913, M. R. Campbell estimated the original reserves of bituminous and semibituminous coal at 112,474,000,000 net tons. In 1921–22, J. F. Reese

[15] The estimate excluded beds less than 2 feet thick, as well as those between 2 and 3 feet thick below stream level, and those between 3 and 6 feet thick lying more than 150 feet below stream level.

calculated the reserves in most of the bituminous counties of the state; these calculations were completed by J. D. Sisler and published in 1928.[16] The results indicated that Pennsylvania had original deposits of 75,093,459,000 net tons, of which 5,823,163,000 tons had been mined out and lost. In 1944, G. H. Ashley modified the estimates of Reese and Sisler and arrived at a figure of 84,616,000,000 tons as the size of the original deposit, of which 9,589,000,000 tons had been mined out and lost.[17] In 1952, the estimate by Ashley of coal mined out and lost was up-dated to December 1950 by M. N. Shaffner to a figure of 11,021,736,000, but Ashley's estimate of original deposits was retained.[18]

The point is that, regardless of which set of figures is used, the depletion of Pennsylvania's coal resources is far from complete. Using the latest data (Shaffner's revision of Ashley's figures), it is apparent that to date only some 13 percent of the bituminous coal of the state has been mined and lost. Examination of the situation in individual counties is equally reassuring (Fig. 10). Even in such heavily mined counties as Allegheny, Fayette, and Westmoreland, from one-half to three-quarters of the original coal remains; and in many other counties over nine-tenths of the original reserves are intact.

What these figures do not reveal, however, is that much of the earlier mining was carried on in the thicker and hence more easily mined seams, and at places where such seams outcropped and thus were more easily attacked. Also, previous mining tended to utilize the seams with higher quality coals, and those most strategically located with respect to transportation routes and markets. Future mining operations will be handicapped by having to utilize less desirable seams at less desirable places; and the extent of the handicap will increase over the years. Fortunately, improved technology is coming to the aid of both the miner and the user of coal, so that to a degree at least the problems of coal extraction and utilization now arising will be overcome. Technological advancements, however, are not an exclusive possession of Pennsylvania, and competing soft coal producing states will presumably derive equivalent advantages from them.

### SUMMARY

Presently available geographical literature on the underground coal mining industry of the Appalachian Plateau is inadequate. Source materials are available, and have been utilized here, to remedy a part of the deficiency for the Pennsylvania portion of the Plateau.

Among the significant findings are the following. Coal seams utilized, among the several score available, are limited in number, and groups of mines tapping each of these seams exhibit distinctive and explainable distributional patterns. Mine entries include both shaft and slope types, as well as the better-known drift type, and regional variations in the distribution of the several types vary with the geology of the area. Mines utilize seams having a wide range of thicknesses; areal differences in thickness are largely a function of the specific seams being tapped. Mine output and mine employment are predominantly on a small scale; a limited number of large- and medium-scale mines, which are concentrated in the southern half of the producing area, are chiefly market oriented rather than resource oriented although the latter factor plays a secondary localizing role. The once-dominant Pittsburgh seam is losing significance, as the impact of changing geologic conditions upon the advancing mining front necessitates more costly operations. Finally, the bituminous coal resources of Pennsylvania, despite long and intensive usage, remain largely intact; but future mining operations must employ less desirable seams at less desirable places.

This article by no means represents a comprehensive analysis of the underground bituminous coal mining industry of Pennsylvania. Significant facets of the industry remain unstudied. These include mine-by-mine differences in quality of coal, kind and degree of mechanization, length of work year, labor efficiency, unionization, and coal shipment methods. Data presently are not available to analyze many of these topics.

[16] J. F. Reese and J. D. Sisler, *Bituminous Coal Fields of Pennsylvania: Part III, Coal Resources*, Pennsylvania Topographic and Geologic Survey, Bulletin M6 (Harrisburg, 1928), p. 7.

[17] *Pennsylvania's Mineral Heritage* (Harrisburg: Pennsylvania Department of Internal Affairs, 1944), p. 83.

[18] Photostated unpublished table received on July 26, 1956, from the Pennsylvania Bureau of Topographic and Geologic Survey.

# KING WHEAT IN SOUTHEASTERN MINNESOTA: A CASE STUDY OF PIONEER AGRICULTURE

HILDEGARD BINDER JOHNSON

*Macalester College, St. Paul*

THE historical geographer is as interested as the geographer of modern agriculture in the extent and duration of changing crop patterns. The significance of crop acreages for the recognition of agricultural patterns was brought out in John C. Weaver's studies of agriculture in the Midwest. While it is true that studies of small areas may not always result in a "meaningful perspective of broader reference,"[1] it is felt that this investigation of pioneer agriculture in a small region of southeastern Minnesota has a bearing on problems in nineteenth-century agriculture elsewhere, at least in many portions of the Midwest.

### THE WHITEWATER WATERSHED

A small natural region, the Whitewater watershed, defined by physical criteria rather than political administrative units, such as counties, was selected as typical of farming areas near waterways in the upper Mississippi basin with respect to topography, accessibility, and time and character of human occupancy. This region lies near to Winona, rated as the fourth primary grain market in the United States in 1868, so that it is likely to have shared in the wheat boom. This drainage basin, comprising roundly 320 square miles, extends into three counties which were major wheat producing areas (Fig. 1). It is large enough to combine the varieties of conditions encountered in the upper and lower parts of watersheds in Mississippi River counties of Minnesota, Wisconsin, and Iowa, and it is small enough to permit intensive field work over the whole region. Original census data of the pioneer period also aid in the study of several aspects of human occupancy.

Southeastern Minnesota consists largely of a number of dendritic drainage basins which are divided into undulating prairie with irregular ridges rising about one hundred feet above the general level of the rolling land, and into more or less steeply-incised valleys originally carved out by glacial meltwaters. Two types of land are agriculturally usable and were occupied simultaneously by pioneer settlers: the loamy soils on the rolling upland and the alluvial valley bottoms and alluvial terraces or so-called tablelands along the main stretches of the streams, such as the Zumbro, Whitewater, Rollingstone, and Root. The original vegetation was a transition from hardwood forests in the east to "first rate" and "second rate" open prairie, as the surveyors described the upland to the west. Oak openings, brush prairie, aspen and birch intermingled in-between. River bottom forests and natural meadows were found in the valleys.[2] Various factors combined to accelerate the process of erosion on the upland, particularly along the ridges; many gullies were formed in the gorges which separate upper and lower watershed areas and along bluffs which rim the main valley; much of the topsoil of the upland is now buried under sand in the valley bottoms. Pioneer agriculture is one important factor in the historical process of erosion, and there is a popular tendency to blame the pioneer farmer for much if not all of the damage to the land because his excessive wheat farming exhausted the soil. On the basis of fairly ample literature of recent and earlier date, the agricultural conditions in southeastern Minnesota during pioneer times can shortly be summarized as follows.[3]

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[1] John C. Weaver, "Changing Patterns of Cropland Use in the Middle West," *Economic Geography*, Vol. 30, No. 1 (January 1954), p. 2.

[2] The original vegetation can be reconstructed in detail from surveyors' descriptive field notes. A large-scale manuscript map, based on this source, was compiled by F. J. Marschner in 1930 for the whole state of Minnesota and is accessible in the Department of Foresty, St. Paul Campus, University of Minnesota.

[3] County histories are too numerous to list; Winona County alone has five. Newspaper files of the Winona *Republican*, the Rochester *City Post*, the Plainview *News*, the St. Charles *Press* for the sixties and seventies are available in the Minnesota Historical Society and broken sets can be complemented by files at local newspaper offices. A number of articles on Minnesota agriculture appeared in *Minnesota History;* those by Merrill E. Jarchow are collected in *The Earth Brought Forth, A History of Minnesota Agriculture to 1885* (St. Paul, 1949). By far the best critical and thorough treatment is Edward Van Dyke Robinson, *Early Economic Conditions and the Development of Agriculture in Minnesota*, Bulletin of the University of Minnesota (Minneapolis, 1915). See also Charles C. Colby, "Agricultural Adjustments to the Natural En-

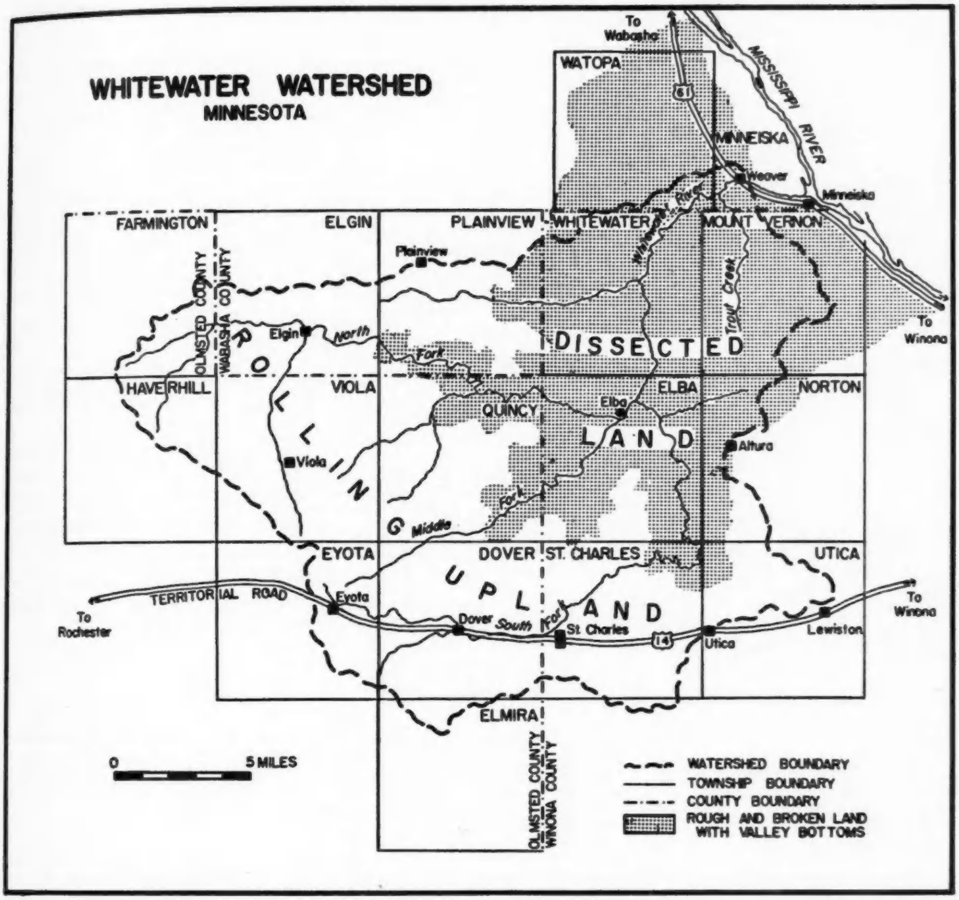


FIG. 1. The Whitewater Watershed wholly or in part drains seventeen townships in Southeastern Minnesota.

### PIONEER SETTLEMENT

Southeastern Minnesota was settled in the middle fifties of the nineteenth century, mostly by natives from New England and the middle colonies and by foreign-born from Germany and Luxemburg. Judging from the states and countries of birth of the children of heads of families, the settlers usually came via Ohio, Indiana, Illinois, and Wisconsin and resided in one or more of these states for a few years before they took up land in southeastern Minnesota, where a number of them terminated their westward migration.[4] Grain farming combined with livestock raising was the agricultural economy familiar to most—if they were farmers. Diversified farming was already established in the eastern part of the Midwest, particularly in Ohio, Indiana, and parts of Illinois. Before the pioneers moved on to the prairie farther west, they occupied the transition region of southern Wisconsin

vironment in Southeastern Minnesota during the Period of Bonanza Wheat Farming," *Transactions of the Illinois State Academy of Science*, Vol. XVII (1925), pp. 213–25.

[4] The manuscript census schedules of population in the United States for 1860 and 1870 permit good insight into family structure, nationality background, routes traveled, and economic status of pioneer families. The stability of land ownership from the time of first transfer of government land to the present is considerable, particularly in the eastern half and in the valley farms of the Whitewater watershed.

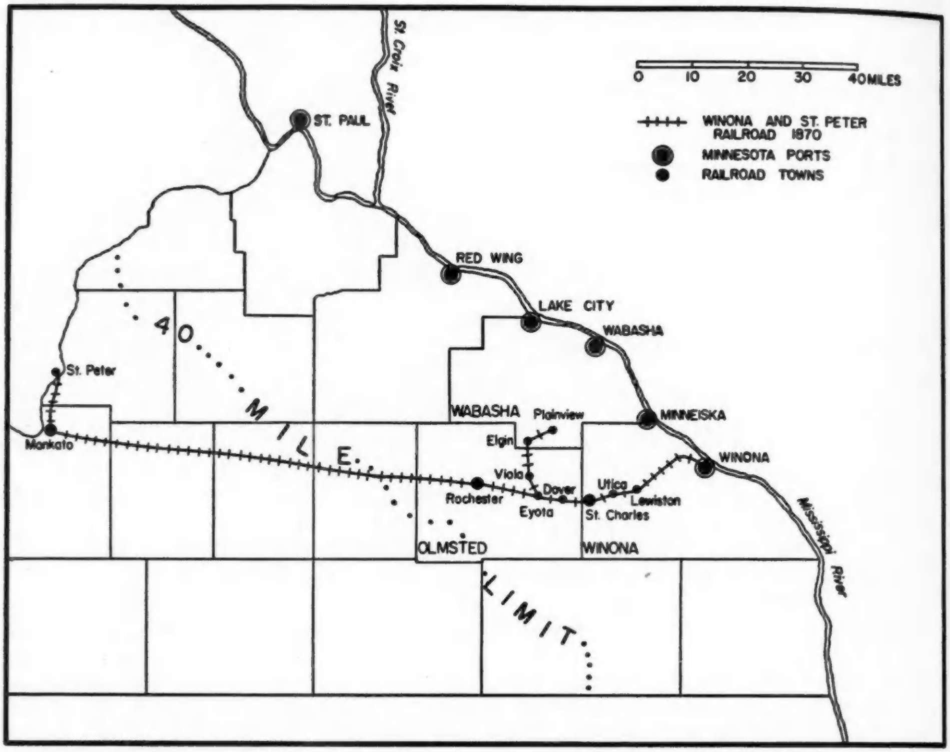


FIG. 2. Location of Southeastern Minnesota relative to transportation during the wheat era. All settlements in the Whitewater Watershed were less than forty miles from ports on the Mississippi. The Winona and St. Peter Railroad reached Rochester in 1864. The spur to Plainview from Eyota was completed in 1878.

and southeastern Minnesota. Here agricultural settlement began at a time when market conditions became favorable to wheat production.

RISE OF WHEAT FARMING

A number of factors led to the outstanding role held by spring wheat among pioneer crops. Rising prices resulted from the demand for wheat and flour by growing populations along the Eastern Seaboard and in Europe, particularly in England. The young cities of St. Paul, St. Anthony Falls, and Minneapolis, with a combined population of over 16,000 in 1860, and the lumber camps in the northern pineries offered a regional market nearby. The Civil War brought a sharp rise in wheat prices, which sold in Minneapolis for fifty cents a bushel in 1861 and for a dollar and a half a bushel in 1866. When prices began to drop after 1868, farmers could make up for decreased profit from the bushel by putting larger acreages into wheat with the help of better agricultural machinery. The first reaper of the Manny type came to Minnesota in 1855, the first threshing machine in 1856, and steam threshing machines were generally available in the sixties.

Wheat production in southeastern Minnesota was favored by the proximity to river ports on the Mississippi. At first, the pioneer farmer relied on "store-pay," namely, on the exchange of his produce for goods from the merchant in a trading place at close hauling distance. In river towns, merchants also exchanged lumber for grain. Laird, Norton and Company, one of the large lumber firms at Winona, advertised as late as 1864 in the Rochester City *Post*: "Grain wanted in Exchange for Lumber." When profit from the handling and shipping of wheat was assured,

cash payment became customary and the farmer, in need of cash, produced wheat which was readily marketable. The river towns were the first cash markets for wheat but interior cash markets also developed early, for instance in Chatfield, in the Root River Valley, from where wheat was shipped to La Crosse, and in Rochester, from where it was shipped to Winona. A committee of the State Legislature investigated market conditions for wheat in 1861 and found that the average distance for the farmers in the state to the nearest navigable river was 80 miles. While a 40-mile belt along the Mississippi is, of course, not identical with the actual distance that a farmer along its western margin would have to travel to reach a river port, it still gives an idea of the favorable market location of southeastern Minnesota and the Whitewater region during the era of shipping by water (Fig. 2).

However, wheat shipments soon encountered new difficulties. Aside from monopolistic price policies, which are not under discussion here, river facilities proved unsatisfactory. Navigation ceased during the winter, and almost every year in June and July for a few days of low water stage. Between 1850 and 1867 the Mississippi was closed 142 days a year on the average. Thus, storage became a vital and irksome factor and prices paid for wheat at river ports depended on the season. From the fall of 1858 to the summer of 1867, the difference between prices paid in fall and winter averaged 4.8 cents per bushel, between those paid in fall and summer, 16.4 cents per bushel. Soon the river towns were not able to provide sufficient storage space for the wheat brought in.[5]

The inability of steamship navigation to handle the volume of wheat hastened the building of railroads. They were basic to the development of bonanza wheat farming in western Minnesota, but in order to reach the west, the railroads had to traverse the eastern areas of earlier settlements and some river towns became railroad terminals. Again, Winona and its hinterland enjoyed a favorable transportation location (Fig. 2). Thus the production of wheat continued in this region of longer occupancy even after yields became lower. Winona County had its greatest wheat harvest in 1877. In 1878, extreme heat alternating with heavy storms ruined the wheat crop and the chinch bug, said to have crossed over into Minnesota from Wisconsin, did additional damage. The year of 1878 is said to mark the turning point, and the end of specialized wheat farming is associated with the census year of 1880.[6] Oats and barley became competitors of wheat as market grains, and hog and cattle raising induced larger corn production. Diversified farming replaced the rule of "King Wheat."

### CONTEMPORARY DESCRIPTIONS

"King Wheat" was the colorful term used by contemporaries and a chapter heading like "Wheat: King or Tyrant?" in a recent study of Minnesota agriculture keeps the concept alive.[7] Early newspapers, local histories and other sources reveal much requoting of the same stories and may, indeed, induce the idea of monocultural wheat farming.[8] An almost irrational dedication to the grain may be illustrated by a few quotations from widely different sources.

According to the Winona *Republican*, October 9, 1861, "the scepter of power was passing from King Cotton of the South to King Grain of the West" due to the Civil War. In 1870, the Commissioner of Statistics stated that "the extensive attention to wheat growing in Minnesota has caused serious neglect of other branches of agriculture." In 1871, he called the production of 7,848,047 bushels of wheat by five counties in 1870 "a noble aggregate," and in 1873 he wrote: "Wheat is becoming a king and through its alliance with

[5] Henrietta M. Larson, *The Wheat Market and the Farmer in Minnesota*, Columbia University Studies (New York, 1926), pp. 38–40. This is an excellent investigation of the economics of early transportation and market conditions of wheat.

[6] Robinson, *op. cit.*, p. 79.

[7] Jarchow, *op. cit.*, p. 165.

[8] Robinson, *op. cit.*, p. 76, calls it "the craze for Wheat." Jarchow, *op. cit.*, pp. 186–87, generalizes somewhat about wheat as "a frontier crop" that "was considered best adapted to the conditions of frontier agriculture," while Theodore C. Blegen in the foreword, p. ix, allots King Wheat "a brief day of glory" only. An example of requoting is the story of a certain E. B. Drews, who seeded two acres to wheat in 1852 near Minnesota City, found in every county history after J. J. Hill, *History of Winona County* (Chicago, 1883), and requoted from Franklyn Curtiss-Wedge, *History of Winona County* (Chicago, 1913), in the admirable scientific *Survey of Erosion and Related Land Use Conditions in Winona County* by Mark H. Brown and Iver J. Nygard, U. S. Department of Agriculture, Soil Conservation Service (Washington, 1941), p. 6.

high transportation rates, a tyrant. Legislation should be directed indirectly against wheat as well as directly against high transportation."[9]

A spirit of rivalry prevailed to achieve high production figures for wheat, and this spirit was at times encouraged by the authorities. In 1876, the Assistant Secretary of State explained in great detail the perturbing fact that no report had been received for 77,032 acres of wheat which should have produced 1,309,564 bushels at 17⅛ bushels per acre. To these unreported bushels he added the reported production of 28,769,736 bushels in Minnesota, the loss of 2,024,972 bushels from grasshoppers and of 2,538,612 bushels from floods. The sum would have resulted in the production of 34,634,884 bushels of wheat in 1875 and "would have placed Minnesota unmistakably and indisputably at the head of the wheat raising states of the Union."[10] Certain townships, where more than 100,000 bushels of wheat had been raised, were listed "for the purpose of giving due credit and prominence to those towns in the state that show a good record." The commissioner also hoped that "hereafter all who have actually raised that amount (namely, 100,000 bushels) will not through inadvertency fail to report, and take the place where they of right belong."[11] The implied reproach for not reporting correctly resorts to the device of praising and making public the names of those who met or surpassed the quota!

The spirit of contest is reflected by an announcement in the St. Charles *Herald*, August 20, 1869, that Dover Township, Olmsted County, was the first to ship wheat that summer. They were "so anxious to get ahead of rival towns that they shipped about six acres in the sheaf without even stopping to thresh it." County histories report all the "firsts" in connection with wheat production: the first winter wheat sown; the first spring wheat harvested—even the section where the event took place in Plainview Township, Wabasha County, is recorded; the first load of wheat teamed to Minneiska; the first wheat shipped out of the county; the first pioneer who shipped wheat via the new Winona and St. Peter railroad—all these and other firsts are usually found in histories of southern Minnesota counties.

A local reporter of 1869 who took a trip by railroad out of Winona was impressed with "the broad and fertile prairie as far as the eye can reach, covered with wheat fields."[12] For readers nation-wide, Harper's *Monthly Magazine*, January 1868, published a lively article which pictured Minnesota as a "land of farms yellow with the golden grain which forms the wealth of the rapidly growing young State." This reporter watched from the porch of the hotel near the railroad station at St. Charles how farmers bid competitively for threshers who just arrived by train and how the whitish dust settled on everything, men, horses, wagons, roads, and then hired himself out as a threshing hand since all the townspeople did it and "the whole community at St. Charles more or less had wheat on the brain."[13]

Such contemporary descriptions reflect views from arteries of transportation and points of receipt and distribution. Shippers' records and elevator receipts also deal with produce that was sold and had reached the road. Local newspapers, published in trading centers, large or small, tell of farming as it was seen from Main Street. Their view rarely included that production which stayed on the farm, particularly when the farm was in a side valley. Diaries by pioneer farmers hardly ever contain systematic information about production and do not report many typical activities since the ordinary farmer did not keep a diary.[14] This leaves statistical data as a source of information.

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[9] *Statistics of Minnesota Pertaining to its Agriculture, Population, Manufactures, etc., etc., for 1869*, First Annual Report of the Assistant Secretary of State to the Governor (St. Paul, 1870), p. 825; *Statistics of Minnesota Pertaining to Agriculture, Manufactures, Population, etc., etc., for 1870*, Second Annual Report of the Commissioner of Statistics to the Governor (St. Paul, 1871), p. 20; *Statistics of Minnesota for 1873*, Fifth Annual Report of the Commissioner of Statistics to the Governor (St. Paul, 1874), p. 188.

[10] *Statistics of Minnesota for 1876* (St. Paul, 1877), pp. 18–20.

[11] *Ibid.*, pp. 32–3.

[12] W. H. Mitchell, *Geographical and Statistical History of the County of Olmsted* (Rochester, 1870), p. 26.

[13] G. W. Schatzel, "Among the Wheat Fields of Minnesota," *Harper's New Monthly Magazine*, Vol. XXXVI (January, 1868), pp. 190–201. A slightly abbreviated reprint appears in Theodore Blegen and Philip D. Jordan, *With Various Voices* (St. Paul: The Itasca Press, 1949), pp. 143–64.

[14] A good example of diaries written by unusual farmers is Rodney C. Loehr, ed., *Minnesota Farmers' Diaries* (St. Paul, 1939).

### STATISTICAL DATA

Statistical records gathered by the state of Minnesota vary in character and arrangement from year to year.[15] The federal agricultural census did not publish data for crop acreages before 1880, i.e., for 1879. By that time, southeastern Minnesota had passed out of the pioneer stage of agriculture. The informative census years are those of 1860 and 1870, that is, between 1850, the stage of wilderness and no recorded agricultural settlement in southeastern Minnesota, and 1880, the year that marks the change to another picture.

A county is often too large a unit to obtain an insight into the distribution of small regional patterns, particularly during the stage of early settlement. Differences in land usage may even be noticeable over the thirty-six square miles of a standard township. But the federal census never grouped data under units smaller than townships. Thus we attempt to determine the role of wheat in pioneer agriculture with the help of the federal manuscript schedules of 1860 and 1870 for the seventeen townships which lie partly or wholly in the Whitewater watershed.[16] Computations are based on 791 individual entries in 1860 and 1,939 entries in 1870.[17]

### CENSUS OF 1860

The census of 1860, reporting for 1859, enumerates under forty-eight columns the number of improved and unimproved acres per farm, cash value of farm and farm implements, the number of heads of different livestock, production of wheat and other grains in bushels, and of butter, cheese, etc., in pounds. Practically all of the harvested cropland in 1859 was in hay, wheat, corn, oats, barley, and rye, although the production of the last two was very scattered and in a few cases one farmer's entry accounts for the production of the whole township. The census makes no difference between wild and cultivated hay, which is regrettable since some of the hay was likely harvested from unimproved acreage during the early stage.

Yields must be assumed on the basis of contemporary information, which may be corroborative or contradictory. The best leads are found in *Statistics of Minnesota*. In 1859, yields for wheat, which received the usual attention, are even reported for a few counties, "superior counties" as they are called, and Winona, Olmsted, and Wabasha are among them with an average yield of 23.6, 23.03, and 22.85 bushels per acre respectively—an average yield for all three of 23 bushels. No county data are given for any other crop. The state average yield was 33.9 bushels for oats, 29.1 bushels for barley, 26.16 bushels for corn, and 23 bushels for rye. The year was very poor for corn; an early frost "cut off the corn crop for southeastern Minnesota by two-thirds, particularly along the Iowa border." On the basis of this state report and some local notices, a yield of 20 bushels of corn per acre is assumed (see Table 1).

### EVALUATION OF DECLARED PRODUCTION

In none of the sixteen townships does the computed acreage of harvested grain begin to reach the acreage reported by farmers as "improved." Watopa Township had only 75 acres more of declared improved acreage than computed grain acreage, and Utica Township had 1,985 acres more, a difference ranging from 16 to 65 percent. When acreage from which hay was harvested is added with a yield of one and a half ton per acre, the computed acreage exceeds the declared acreage in six townships. This shows what can be expected, that some hay came from unimproved acres as wild hay. No consistent relationship can be recognized between the existence of natural meadows, a good potential for wild hay, and the excess of computed grain plus hay acreage over declared improved acreage. On the other hand, the computed grain-plus-hay acreage does not even approximately account for the declared improved acreage in two town-

[15] The state of Minnesota published *Statistics of Minnesota* annually from 1857 to 1861 and from 1868 to 1896, and resumed publication of agricultural statistics in 1925 at varying intervals. Early years rarely contain township data; recent data for townships are accessible upon request in the Minnesota Department of Agriculture, Division for Statistics.

[16] The schedules, bound in folio volumes, are in the manuscript division of the Minnesota Historical Society. The arrangement of figures in columns facilitates excerpts and summaries; the writing is very legible. This contrasts with the schedules for 1880 where the writing is poorer and a block arrangement for each entry with subdivisions would make excerpting and summarizing an awkward and trying task.

[17] In 1860, one of the seventeen townships is not contained in the records. That the townships cover a larger area than the watershed actually comprises is not relevant in this study. All computations were worked out to two decimal places and rounded off.

TABLE 1.—PRODUCTION OF SELECTED CROPS IN SIXTEEN TOWNSHIPS, WHITEWATER WATERSHED, MINNESOTA, 1859[1]
(in acres)

| Township | Wheat | Corn | Oats | Barley | Rye | Hay | Number of farmers reporting |
|---|---|---|---|---|---|---|---|
| *Olmsted County* | | | | | | | |
| Dover | 374 | 260 | 253 | 18 | — | 449 | 40 |
| Elmira | 385 | 391 | 218 | 1 | 1 | 515 | 50 |
| Eyota | 873 | 643 | 608 | 30 | — | 723 | 80 |
| Farmington | 309 | 390 | 39 | — | 45 | 315 | 40 |
| Haverhill | 532 | 655 | 541 | 15 | 34 | 618 | 86 |
| Quincy | 387 | 308 | 210 | 3 | 9 | 323 | 39 |
| Viola | 239 | 276 | 179 | — | 6 | 366 | 39 |
| *Wabasha County* | | | | | | | |
| Elgin | 677 | 584 | 571 | 26 | 16 | 695 | 79 |
| Plainview | 953 | 617 | 619 | 12 | 46 | 730 | 86 |
| Watopa | 30 | 40 | 23 | 14 | — | 109 | 10 |
| *Winona County* | | | | | | | |
| Elba | 21 | 239 | 93 | 26 | 1 | 263 | 25 |
| Mount Vernon | 96 | 119 | 26 | — | — | 114 | 14 |
| Norton | 278 | 159 | 102 | 2 | 14 | 285 | 21 |
| St. Charles | 810 | 1,269 | 694 | 57 | — | 620 | 74 |
| Utica | 1,175 | 932 | 633 | 36 | 21 | 664 | 87 |
| Whitewater | 140 | 216 | 50 | 2 | 3 | 207 | 21 |

[1] Data were compiled from original U. S. census schedules. Minneiska, Wabasha County, is not listed in 1859. Acreages were computed on the basis of reported production and an assumed yield of 23 bushels of wheat, 20 of corn, 33 of oats, 30 of barley, 23 of rye, 1½ tons of hay per acre.

ships where the discrepancy is still more than one thousand acres.

Technical inaccuracies inherent in census schedules offer no explanation. It might be argued that assumed yields were too high. A random sample of thirteen entries shows that the computed grain acreage alone surpasses declared improved acreages in three cases while it does not suffice in ten others (see Table 2). This cannot be explained by yields varying greatly from farm to farm: an example of ten consecutively listed individual

TABLE 2.—CROP ACREAGES ON THIRTEEN FARMS, SELECTED AT RANDOM IN ST. CHARLES TOWNSHIP, WINONA COUNTY, MINNESOTA, 1859[1]

| Grain | | | | | Declared improved acreage | Difference between improved and grain acreage | Hay |
|---|---|---|---|---|---|---|---|
| Wheat | Corn | Oats | Barley | Total | | | |
| 3.5 | 20.0 | 1.3 | — | 24.8 | 14 | −10.8 | 8.0 |
| 5.5 | 15.0 | — | — | 20.5 | 80 | 59.5 | 5.3 |
| 6.5 | 6.0 | 6.0 | — | 18.5 | 30 | 11.5 | 10.0 |
| 8.7 | 10.0 | 4.5 | — | 23.2 | 20 | −3.2 | 5.3 |
| 6.7 | 15.0 | 9.0 | — | 30.7 | 37 | 6.3 | 12.7 |
| 3.7 | 15.0 | 9.0 | — | 27.7 | 18 | −9.7 | — |
| 19.5 | 20.0 | 21.2 | 12.0 | 72.7 | 150 | 77.3 | 20.0 |
| 5.5 | 2.0 | 3.0 | — | 10.5 | 30 | 19.5 | 6.7 |
| 3.0 | 4.0 | 3.5 | 1.0 | 11.5 | 25 | 13.5 | 6.7 |
| 17.4 | 15.0 | 18.1 | 1.6 | 52.1 | 60 | 7.9 | 9.3 |
| 12.1 | 2.5 | 9.0 | 1.6 | 24.8 | 45 | 20.2 | 10.0 |
| 8.7 | 2.5 | 3.0 | — | 13.8 | 50 | 36.2 | 8.0 |
| 8.7 | 5.0 | 18.8 | — | 32.5 | 70 | 37.5 | 13.3 |

[1] Acreages are computed from declared production of grain (in bushels) and hay (in tons). None of the thirteen farmers declared rye production in original agricultural census schedules for 1859.

TABLE 3.—CROP PRODUCTION AND ACREAGE AS SHOWN BY TEN CONSECUTIVELY LISTED CENSUS ENTRIES IN ST. CHARLES TOWNSHIP, WINONA COUNTY, 1859

| Farmer | Wheat | | Oats | | Corn | | Barley, acres | Total grain, acres | Declared improved, acres |
|---|---|---|---|---|---|---|---|---|---|
| | Bu. | Acres | Bu. | Acres | Bu. | Acres | | | |
| A | 190 | 8.2 | 493 | 14.9 | 350 | 17.5 | 3 | 43.6 | 32 |
| B | 42 | 2.0 | — | — | 100 | 5.0 | – | 7.0 | 10 |
| C | 165 | 7.0 | 221 | 6.7 | 150 | 7.5 | – | 21.2 | 30 |
| D | 100 | 4.3 | 200 | 6.0 | 400 | 20.0 | – | 30.3 | 40 |
| E | 155 | 6.7 | 300 | 9.0 | 300 | 15.0 | – | 30.7 | 37 |
| F | 115 | 5.0 | 100 | 3.0 | 300 | 15.0 | – | 23.0 | 50 |
| G | 240 | 10.0 | 180 | 5.4 | 100 | 5.0 | – | 20.4 | 35 |
| H | 57 | 2.5 | 110 | 3.5 | 100 | 5.0 | – | 11.0 | 16 |
| I | 125 | 5.4 | 50 | 1.5 | 100 | 5.0 | – | 10.9 | 25 |
| J | 86 | 3.7 | 298 | 9.0 | 300 | 15.0 | – | 27.7 | 18 |

entries of neighboring farms shows the same variation (see Table 3). Quality of soil, effects from grasshoppers, hail, drought, or diseases are not likely to have varied much over these altogether 930 acres of farmland of which 293 acres were declared as improved.[18] In some cases computed grain acreage again surpasses declared improved acreage, and in the greater number of cases, it does not come near to it. Checks in other townships show similar variations and also the tendency of greater discrepancies on farms where the declared improved acreage is comparatively large.

The explanation is psychological. The farmers estimated the number of acres that they had improved or not improved. These estimates were in figures which usually add up to even quarter sections, half quarter sections, or quarter quarter sections—160, 80, or 40 acres, respectively. In only five out of seventy-four entries in St. Charles, for instance, the number of acres declared by farmers is not evenly divisible by ten. But farms often do not have a round number of acres on account of correction lines of the survey. Secondly, farmers were for various reasons inclined to overestimate rather than underestimate the number of acres they had improved, aside from lenient interpretation of the term "improvement."

A further explanation is offered by the declared figures for production. Six of thirteen farmers in Table 2, for instance, reported uneven numbers of bushels of wheat produced; the production figures for corn are all divisible by 20, 25, or 50. Only one in ten figures of wheat production in Table 3 is a round figure, but all numbers for corn production are divisible by fifty. The 25,275 bushels of corn produced in St. Charles Township in 1859 are made up of 40 individual returns in hundreds, twelve in fifties, seven in twenty-fives, and six in tens, as in 300, 250, 125, and 60 bushels. The numbers for the production of oats are not as one-sided and revealing as those for wheat and corn. Round numbers are far more frequent than exact numbers. The attempt to link estimated or exact figures to the presence or absence of horses and working oxen on farms proved unsuccessful. But it is obvious that there is a different basis and validity for figures of production, such as the following: Farmer A. B. in Elba with 120 acres improved out of 240, reports 1,051 bushels of wheat, 400 of corn, 687 of oats; farmer J. H. in Jefferson with 80 acres improved out of 320, reports 725 bushels of wheat, 70 of corn, and 300 of oats; farmer I. W. in Whitewater with 15 acres improved out of 65, reports 145 bushels of wheat, 200 bushels of corn, and no oats. It is idle to speculate as to the individual honesty of the farmers and their ability to estimate closely. Significant is the reflection of the agricultural economy in the individual entries, namely, the tendency to estimate the production of a crop which stayed on the farm and was not weighed or measured, such as corn, but to give exact figures for crops which found their way to mills and market places, particularly wheat.

[18] On account of the natural practice of the assistant marshal to go from farm to neighboring farm, consecutively listed entries frequently report for a continuous area. A check of names in the census and on old plat maps (the first, available for Winona County, dates from 1864) helps to prove proximity of these farms.

### WHEAT, CORN, HAY ACREAGES IN 1860

With due allowance for uncertainties inherent in the computations, the following statements about crop acreage in 1860 are made. Wheat occupied from 28 to 50 percent of the acreage under grain and in six townships from 40 to 50 percent of the grain acreage. Of these, Utica, Dover, and Eyota were upland townships and traversed by the territorial road. Quincy, directly north of Dover, had good access to it. Norton was connected with the road through the Rollingstone valley. The small production of 2,218 bushels from 96 acres in Mount Vernon must have come from the farms in Trout Creek valley. The wheat production in the four townships of Utica, St. Charles, Dover and Eyota along the territorial road from east to west accounts for almost half of the total acreage in the sixteen townships, or for 3,231 acres out of a total of 6,954 acres. From the territorial road, observers would, indeed, see many fields of wheat. By 1864, the railroad from Winona to Rochester was completed parallel to the road on the upland.[19] So the passengers on the railroad saw only the "prairie covered with wheatfields as far as the eye could reach," close to the new major means of transportation. Today, the motorists see only the rolling upland with its farms and are unaware of the drastically different wilderness landscape in the valleys which are hidden between highway No. 14 in the south and highway No. 16 along the Mississippi just north of the watershed.

[19] Lewiston, Utica, Dover, and Eyota are all elevator towns and plotted along the railroad in 1873, 1866, 1869, and 1864.

In nine out of sixteen townships, corn was harvested from a larger acreage than wheat. Hay acreages exceeded wheat acreages in eleven out of sixteen townships. The share of harvested wheat acreage from harvested grain and hay acreage ranged from 14 to 34 percent. On the average, 40 percent of acres in grain were in wheat, but only 27 percent of all cropped acres produced wheat. Roundly, three-fifths of the grain acreage was occupied by corn, oats, barley, and rye, with so small an acreage for the last two that corn and oats were heavy competitors for wheat. Wheat played the role of a dominant crop barely and only among grains. When it is realized that the total acreage in all townships under hay (6,999 acres) was as large as the number of acres which produced wheat (6,954), pictorial illustrations showing the pioneer farmer around 1860 cutting hay are as appropriate as reproductions of threshing machines in wheat fields.

### WHEAT IN 1870

The ten years from 1870 to 1880 saw the ascendancy of wheat to its role as king. The general development in the three counties under discussion, which in 1879 still produced approximately 12 percent of all wheat in the state on about 12 percent of the total wheat acreage in Minnesota, is shown in Table 4. Acreages had to be computed for 1859 and 1869; they were reported in 1879. The beginning of a change is faintly indicated in Wabasha County. Olmsted County, because of topography and location of productive farmland close to railroad transportation,

TABLE 4.—WHEAT ACREAGE AS PERCENTAGE OF GRAIN AND HAY ACREAGE IN THREE SOUTHEASTERN MINNESOTA COUNTIES DURING THE PIONEER PERIOD[1]

| County | 1859 (computed)[2] Wheat as percentage of— | | 1869 (computed)[3] Wheat as percentage of— | | 1879 (reported) Wheat as percentage of— | |
|---|---|---|---|---|---|---|
| | Total grain | Grain and hay | Total grain | Grain and hay | Total grain | Grain and hay |
| Winona | 36.00 | 26.76 | 72.71 | 65.22 | 73.18 | 65.17 |
| Olmsted | 36.46 | 34.68 | 74.75 | 64.35 | 90.24 | 76.43 |
| Wabasha | 31.27 | 19.93 | 73.85 | 68.67 | 73.52 | 67.23 |

[1] Data for production in bushels in 1859 and 1869 from Edward Van Dyke Robinson, *Early Economic Conditions and the Development of Agriculture in Minnesota* (Minneapolis, 1915), pp. 260–65, 273–74. Acreage for counties in 1879 recorded in *Report on the Production of Agriculture*, Tenth Census, June, 1880 (Washington, 1883), pp. 194, 288.

[2] Acreage computed on the basis of 23 bushels of wheat, 20 of corn, 33 of oats, 30 of barley, 23 of rye, 1.5 tons of hay per acre.

[3] Acreage computed on the basis of 19 bushels of wheat, 28, 32, 35 of corn, 42 of oats, 22, 35, 30 of barley, 19 of rye, 1.4 tons of hay per acre.

was generally more suitable for wheat production on a large scale than the river counties of Wabasha and Winona. Here land use capabilities vary over wider areas and "King Wheat" does not seem to have "ruled" more than two thirds of the cropped land in general. By 1870 the dominant role of wheat in crop patterns appears established in the three counties and must be reflected also in the seventeen townships which contain, on a smaller scale than the counties, upland and valley farms typical of the region.

The schedules of 1870 are essentially the same as those of 1860 with one addition: reported farmland is divided into improved, "other unimproved," and woodland acres. The sum of the number of acres which the farmers reported under these three classes results in a discrepancy: in three townships the farmers reported ownership of more land than each township contains according to the best available information.[20] The problems connected with the exact determination of areal sizes become more recognizable in dealing with small units and make percentage figures of comparisons between total land area and cropland questionable. In Minneiska, Elba, and Whitewater townships, traversed by the main Whitewater River and covered partially by very broken land, half and less than half of available land was claimed by farmers. In Watopa, Minneiska, Elba, Whitewater, Mount Vernon and Norton, farmers had more acres in woodland and unimproved land than in improved land. In the upper watershed, where land was almost fully occupied, roughly three out of four acres were improved.

Acreages for 1870 in Table 5 can be computed with greater confidence than for 1860. *Minnesota Statistics* published data for yields of crops for every county. Thus the divisor changes for corn, barley, and hay with different townships dependent on their location in Olmsted, Wabasha, and Winona counties. It is statistically correct and justified in view of the extent and location of the townships, although it induces the ironic circumstances that in a few cases fields which actually border each other are assumed to have had different yields because they lie in different counties.

The differences between computed acreage for major crops and reported improved acreage range from 4 to 26 percent. In Elgin Township the computed acreage surpasses the declared improved acreage by 419 acres. These differences are smaller than in 1860. Some absolute figures show a very close estimate. In Minneiska, for instance, only 56 improved acres are left to account for the production of buckwheat, peas and beans, Irish potatoes, and orchard products. But it is certain that some of the hay—the census again does not distinguish between wild and cultivated hay—must have come from unimproved acres. In Minneiska, oldtimers still remember cutting wild hay on marshland after World War I, and therefore the difference between improved acreage and acreage computed for grain and hay was more than 4.4 percent of the former. Other absolute figures for unaccounted acreages are very large—4,207 acres in Dover, 2,877 in Plainview, 2,678 in Utica. The high percentage differences are in Dover (26), in Haverhill (20), in Watopa (21), and in Mount Vernon (25). These four townships are very different in character. Only Dover and Haverhill are upland wheat townships. The explanation that discrepancies were caused by overestimating wheat

[20] The figures for the area of townships, divided into land and water area, found in the *United States Census*, 1940, are for square miles and result, when converted into acres, in a different set of numbers than the figures obtained from the State Auditor's office. The latter, computed in 1919 with the help of several sources and government agencies, were used. Explanations are: (a) Some farmers likely included in their reports acres that were not in the township of their residence. Land holdings that straddle township, even county boundaries, originated with the first deed, i.e., the first transfer of government land to private ownership, even for holdings of 160 acres. (b) Farmers may not have deducted water areas from land areas. (c) Landowners are apt to think of their holdings in terms of 160, 80, and 40 acres, and to forget the differences between the round figures and their actual holdings which result from the impossibility to apply the laws, as they were worded, to the natural conditions of the curving surface of the earth. Official description in the Land Office Record deed book also is by quarters and halves, no matter how broken the figures for holdings. Examples, from a long list dating from 1855 and the first transfer, are: Claim 468 Whitewater Township, described as SW¼ of Sec. 19, with 147.06 instead of 160 acres; claim 403 in Utica Township, described as W½ of NW¼ of Sec. 18, with 74.67 instead of 80 acres. After intensive study of the problems of surveying one can only concur in the advice from the State Auditor's office to add "more or less" to all acreage figures in land deeds and titles.

TABLE 5.—ACRES OF SELECTED CROPS IN SEVENTEEN TOWNSHIPS, WHITEWATER WATERSHED, MINNESOTA, 1869[1]

| Township | Wheat | Corn | Oats | Barley | Rye | Hay | Number of farmers reporting |
|---|---|---|---|---|---|---|---|
| *Olmsted County* | | | | | | | |
| Dover | 8,277 | 780 | 1,225 | 362 | — | 1,147 | 135 |
| Elmira | 8,146 | 770 | 1,513 | 182 | — | 958 | 125 |
| Eyota | 8,235 | 915 | 3,082 | 123 | — | 1,692 | 144 |
| Farmington | 1,938 | 422 | 2,419 | 458 | — | 789 | 130 |
| Haverhill | 4,946 | 259 | 761 | 70 | — | 701 | 95 |
| Quincy | 8,158 | 680 | 3,145 | 433 | — | 885 | 133 |
| Viola | 7,465 | 647 | 1,586 | 299 | — | 1,129 | 126 |
| *Wabasha County* | | | | | | | |
| Elgin | 12,135 | 525 | 2,552 | 600 | 6 | 567 | 140 |
| Minneiska | 431 | 177 | 116 | 5 | 2 | 532 | 33 |
| Plainview | 8,964 | 858 | 2,111 | 662 | 7 | 644 | 148 |
| Watopa | 1,817 | 470 | 297 | 53 | — | 569 | 89 |
| *Winona County* | | | | | | | |
| Elba | 3,606 | 346 | 498 | 65 | — | 307 | 85 |
| Mount Vernon | 3,270 | 414 | 439 | 40 | 2 | 163 | 91 |
| Norton | 5,081 | 444 | 809 | 157 | 65 | 353 | 100 |
| St. Charles | 7,732 | 689 | 1,443 | 286 | — | 543 | 122 |
| Utica | 10,077 | 700 | 1,849 | 424 | 7 | 1,019 | 167 |
| Whitewater | 1,441 | 471 | 427 | 11 | 15 | 538 | 76 |

[1] Data compiled from report of bushel production in original U. S. census schedules. Acreages computed on the basis of an assumed per-acre yield of 19 bushels of wheat; 32 bushels of corn in Olmsted, 35 in Wabasha, 28 in Winona County; 42 bushels of oats; 35 bushels of barley in Olmsted, 30 in Wabasha, 22 in Winona County; 19 bushels of rye; 1.3 tons of hay in Olmsted, 1.5 in Wabasha and Winona County.

yields is not satisfactory. Furthermore, while low yields were likely in those areas that had been cultivated to wheat long and extensively, and Dover, Plainview, and Utica occupy locations that were particularly favorable for wheat production, Dover and Utica are two of the three townships where farmers reported more land in farms than the townships comprised. Unaccounted improved acreage figures merit particular caution in these two cases. As long as Mount Vernon with 3,270 computed acres of wheat has a discrepancy of 25 percent and Utica with 10,077 computed acres has one of 9 percent, it is not promising to search for explanation in the computation of yields.

### A TYPICAL "WHEAT TOWNSHIP" IN 1869

Plainview Township with a production of 170,315 bushels of wheat—exceeded only by the production of Farmington and Utica townships with even more favorable transportation location and hardly any unusable land—was a representative wheat township in 1870. In 1869, the year for which the census of 1870 is valid, a writer whose observations are generally astute and apparently supported by specific information rather than impression, reported for Plainview: "Nearly three fourths of 7,698 acres of land were sown to wheat, yielding an average of nineteen bushels while roundly 2,000 acres were sown to other grain with more than average yields."[21] This unusually restrained statement implies that 109,697 bushels of wheat were produced on 5,774 acres. According to the 148 entries in the census for Plainview Township 170,315 bushels of wheat were produced, for which 8,964 acres were needed. This does approach three-fourths—not of "the land," but of the land in grain since wheat occupied 71 percent of the acreage under wheat, corn, oats, barley, and rye in 1869 according to the computation. At the same time, wheat acreage amounted to

[21] W. H. Mitchell, *op. cit.*, p. 90. Characteristic of the usual contemporary observation is a letter from a farmer at Greenwood Prairie in Plainview Township, June 1861, in the *Minnesota Farmer and Gardener*, Vol. II No. 1 (1861): "I think I can well afford as every one else to claim one acre for such purposes (as currants and other fruit) while ninety-nine are producing wheat."

68 percent of the land in grain and hay, and to only 56 percent of declared improved land. The individual figures for declared improved acreages are subject to the same reservations discussed before.

For a full understanding of land usage, 5,966 acres of unimproved land and woodland on the 148 farms cannot be ignored. They amounted to 27 percent, a good fourth, of land in farms and were without a doubt partially used for pasture in Plainview Township. Woodland grazing is still a practice on many farms of the region although sharply condemned by conservation agents. It is a dangerous practice but was general during the early period. While approximately twice as many acres were in wheat as in corn, oats, barley, rye, and hay together (8,964 compared with 4,282 acres), an unknown fraction of the 5,966 acres in woodland and unimproved land was indirectly harvested through pasture and contributed to the production of 31,500 pounds of butter—an average of 213 pounds per farm—and 550 pounds of cheese. The acreage claimed for minor and various purposes, like the production of 877 bushels of orchard products, 100 pounds of hops, 267 bushels of buckwheat, 332 bushels of beans and peas, and 8,187 bushels of potatoes, was small. But together with the listing of 41 horses, 11 mules, 359 milch cows, 66 working oxen, 443 head of "other cattle," 88 sheep, 523 swine they indicate more diversified land usage than the statement that three quarters of the land produced wheat.

The frequent comment that every farmer grew wheat may be acceptable; only ten out of 148 in Plainview Township reported no wheat, while 20 reported no oats, 34 no corn, 55 no hay, and 105 no barley. It should be kept in mind, however, that some acres were used for purposes other than grain and hay, that some woodland was used for pasture and that the same psychological factors which were discussed for 1859 are about equally valid for 1869, particularly the habit to estimate production that was not marketed. Then it is also acceptable to describe the land usage in Plainview Township in 1869 by saying that 8,964 acres of wheat amounted to about half or even less than half of 16,123 improved acres and to about two fifths of the 22,089 acres of all land on farms.

### LAND USAGE OF UPLAND AND LOWLAND

Some differences in land usage of upland and lowland in the Whitewater watershed in 1860 and 1870 are recognizable. In Minneiska Township, 33 farms produced an average of 362 pounds of butter per farm, and had 3.6 milch cows and 7.5 other cattle per farm. In Utica, 167 farms produced an average of 208 pounds of butter per farm and had 2.3 milch cows and 2.3 head of cattle per farm. Minneiska had as excellent an outlet for wheat in the port of Minneiska as Utica had through the railroad but its bottomlands, which made up most of the farmland in use, were not so well suited for wheat as the soils in Utica, and more acres were in hay than in wheat. Generally, the relationship between wheat production and the need for horsepower led to an increase of oats over corn acreage. In 1860, corn acreage surpassed oats acreage in every township, but in 1870 it did so only in Minneiska, Whitewater and Watopa. In Minneiska, where more acres were in corn than in oats, wheat occupied 59 percent of the grain acreage and 34 percent of the grain and hay acreage. In Whitewater and Watopa, where bottomlands made up much of the desirable farmland and wheat acreages rank not impressively high, more acres were also in corn than in oats. The bottomlands of Elba also were better suited for corn than for wheat; but a larger share of upland had been put into use in this township and the presence of two local mills in the village of Elba and at Fairwater Mills may have contributed toward the increased wheat production. Why the upland prairie township of Eyota should have wheat on only 61 percent of land under grain and on only 58 percent of land under grain and hay is difficult to explain. Its land use capability is very comparable to that of neighboring Dover with 78 and 70 percent respectively, or of St. Charles with 76 and 72 percent. Thus, the generalization that upland townships with a large share of rolling prairie had larger acreages in wheat than townships with much broken and bottom land has its exceptions.

The picture is not consistent. Still, wheat occupied from three- to four-fifths of the grain acreage and two-thirds of the acreage under grain and hay in the whole region of the Whitewater watershed. Significant is the distribution of major wheat producing town-

ships. Out of 101,527 acres of wheat computed for the seventeen townships in 1869, 34,121 acres, that is, one-third, were in the four townships of Utica, St. Charles, Dover, and Eyota. With the 20,902 acres in the upland townships of Plainview and Farmington, the location of a good half of the wheat acreage is determined. When 54 percent of the wheat acreage is located in 36 percent of the area, an imbalance of the over-all distribution pattern is indicated. Larger wheat acreages on the upland may represent an "agricultural adjustment to the natural environment."[22] But they are also a result of transportation facilities.

### SUMMARY

It is often assumed that wheat was a monocrop in southeastern Minnesota for at least two decades after settlement began. This view is based largely on contemporary literature which not only described the production of wheat but promoted it. After an evaluation of statistical data for the smallest available unit of the township and the computation of acreages from declared production in bushels, wheat is reduced to a major crop among grain only in 1859 and can be called the outstanding, but not the only crop in 1869. Thus we should modify a stereotype which is reiterated, for instance, in the 75th jubilee edition of the Winona *Republican Herald*, November 20, 1930: "Wheat was practically the only crop in Winona County until 1877." This is an exaggeration.

Two factors must be considered: (1) Contemporary literature deals mostly with cash crops and reflects largely the historical geography of communication and transportation; it overlooks, even ignores, that farm production which stayed on the farm and did not reach any market or distribution point. (2) Original data are self-evident with respect to precise declaration and round estimates of production: they reveal information that is lost in published totals.

The variety of conditions which prevail over the Whitewater watershed makes the concept of "King Wheat" an over-simplification for pioneer agriculture, comparable to the concepts of Corn-belt and Cotton-belt of more recent date. For a true understanding of land usage in the past, we should avoid the perpetuation of historically developed labels.

[22] Colby, *op. cit.*, arrives at this evaluation and title after investigating published data of production for counties.

# A CONTRIBUTION TO STRUCTURAL VEGETATION MAPPING

PHILIP L. WAGNER
*University of Chicago*

*. . . In determining these leading forms or types, on the individual beauty, the distribution, and the grouping of which the physiognomy of the vegetation of a country depends, we must not follow the march of systems of botany, in which from other motives the parts chiefly regarded are the smaller organs of propagation, the flowers and fruit; we must, on the contrary, consider solely that which by its mass stamps a peculiar character on the total impression produced, or on the aspect of the country. . .*

—ALEXANDER VON HUMBOLDT

Vegetation, as Humboldt pointed out long ago, is the feature that lends the quality of uniqueness to any landscape, and is one of the chief elements in our perception of geographic diversity. No other feature of the landscape varies so consistently and so distinctively from place to place, tending with time toward ever greater specialization in each locality and subsisting with more or less continuity in the face of many successions of culture and occupance. It is well known, too, that vegetation expresses in its structure and floristic composition a close adjustment to factors of the physical environment.

The present paper attempts to offer a geographical contribution to vegetation study, seeking to relate current thought in this field to the problem of vegetation mapping and, proceeding from the foundations established in the work of A. W. Küchler and others, to set forth an original approach to the design of vegetation maps which will satisfy the interests and needs of geographers.

The geographic study and mapping of vegetation must depend for its basic categories and concepts upon the work of ecologists, botanists, and others in this field, of which Raup, and more recently Kendeigh, have given useful summaries.[1] Since the great pioneering work of Humboldt, which established the geographic study of vegetation as a distinctive scientific field—and which, incidentally, constitutes a claim on this field for geographers, by right of prior discovery—several different trends have developed in the study of vegetation. The largest amount of detailed knowledge has been amassed by the botanists and paleobotanists who follow the floristic approach, of which the methods and concepts are well presented by Cain and Vul'f.[2] The floristic plant geographers seek to discover the conditions and means of plant dispersal and establishment in past and present, and to mark out the areal patterns resulting therefrom. Many of their results are published as regional floras and monographs, based on herbarium collections, and several general summaries of floristics for the world as a whole are available, of which those of Good and Newbigin are the most readily accessible to the non-specialist.[3] Floristic plant geography makes ample use of cartography, both for its treatment of environmental conditions and for the recording of past and present distribution of plants, but its data are not ordinarily of primary interest to the general geographer.

An alternative to the floristic approach to vegetation study is presented by the physiognomic or morphological point of view, which considers the physical forms of plants and their spatial interrelations within complex communities, regardless of taxonomic affinities. This is the approach of the "structural" school of vegetation science which arose quite recently as a product of exchange and synthesis among British botanists, ecologists, and foresters, who were confronted with the problem of developing a single consistent and workable system of vegetation to fit the nu-

[1] Hugh M. Raup, "Trends in the Development of Geographic Botany," *Annals*, Association of American Geographers, Vol. XXXII, No. 4 (1942), pp. 319–54; S. C. Kendeigh, "History and Evaluation of Various Concepts of Plant and Animal Communities in North America," *Ecology*, Vol. 35, No. 2 (1954), pp. 152–71.

[2] Stanley A. Cain, *Foundations of Plant Geography* (New York and London: Harper, 1944); Evgenii V. Vul'f, *An Introduction to Historical Plant Geography*, trans. Elizabeth Brissenden (Foreword by Elmer D. Merrill; Waltham, Mass.: Chronica Botanica, 1943.)

[3] Ronald D'Oyley Good, *The Geography of the Flowering Plants* (2d ed.; New York and London: Longmans, Green and Co., 1953.); Marion I. Newbigin, *Plant and Animal Geography* (London: Methuen, 1936).

merous and tremendously diverse local situations in a worldwide empire. Tansley, who was strongly influenced both by Braun-Blanquet and by Clements, produced the first attempt at unifying different local approaches into a general vegetation scheme which could be applied easily and meaningfully in all of the British tropical possessions, and a number of other British workers, notably Beard and Richards, have carried on in this direction.[4] The structural school pays relatively little heed to floristic composition and does not incorporate physiological or developmental considerations into its classification schemes, although it employs floristic, physiological and successional concepts in the elucidation of problems related to the structure of vegetation.

The structural analysis of vegetation proceeds from observation of the size, position, and form of individual plants to generalization about the characteristic combinations and relations among these features in each given vegetation. The fundamental principles of structural vegetation work have been set forth in concise form by Richards, Tansley, and Watt,[5] and the advantages of the structural approach for geographic work have been clearly and brilliantly presented by Küchler and by Dansereau.[6]

A. W. Küchler in particular has devoted much thought and research to the problem of applying structural classifications in cartography, for which he has presented a system of his own.[7] Küchler's vegetation categories embrace all of the major combinations of significant structural variations, which are represented by a flexible set of literal symbols that can be arranged into formulae to correspond to any given vegetation. A cartographic application of Küchler's system is exemplified in a recent publication, in which his approach is compared with several other types of vegetation maps.[8] Küchler represents the vegetation of the area considered by a mosaic of small, areal segments marked off by linear boundaries and colored to represent the structure of the vegetation within them according to a conventional code.

## II

The approach to vegetation mapping which is outined in the ensuing pages seeks to preserve as far as possible the structural characteristics of vegetation, and to present them in a simple and readily intelligible conventional form, while at the same time maintaining the property of continuous and gradual areal variation corresponding to reality. To achieve this end, the map symbolizes structural relationships along horizontal transect lines and produces a secondary over-all pattern at another level of generalization.

The symbolic system of the map is derived directly from the methods employed in structural vegetation study to record information on the structure of plant communities, and embodies the vegetation profile in cartographic form. The use of vegetation profiles has frequently been described and illustrated in ecological literature, and has been discussed at length by Christian and Perry, Richards, and Dansereau.[9] The profile expresses the form, size, and spatial relations among plants in a vertical plane, and the characteristic and recurrent patterns which are created by these relations in each vegetation. It may

[4] J. S. Beard, "Ecological Studies upon a Physiognomic Basis," *Lilloa*, Vol. 20 (1949), pp. 45–53; "The Savanna Vegetation of Northern Tropical America," *Ecological Monographs*, Vol. 23, No. 2 (1953), pp. 89–100; P. W. Richards, *The Tropical Rain Forest. An Ecological Study* (Cambridge, England: Cambridge University Press, 1952).

[5] P. W. Richards, A. G. Tansley, and A. S. Watt, "The Recording of Structure, Life Forms and Flora of Tropical Forest Communities as a Basis for their Classification," *Journal of Ecology*, Vol XXVIII, No. 1 (1943), pp. 224–37.

[6] A. W. Küchler, "A Geographic System of Vegetation," *Geographical Review*, Vol. XXXVII, No. 2 (1947), pp. 233–40; "A Physiognomic Classification of Vegetation," *Annals*, Association of American Geographers, Vol. XXIX, No. 3 (1949), pp. 201–10; "The Relation between Classifying and Mapping Vegetation," *Ecology*, Vol. 32, No. 3 (1951), pp. 275–83. Pierre Dansereau, "Description and Recording of Vegetation upon a Structural Basis," *Ecology*, Vol. 32, No. 2 (1951), pp. 172–229.

[7] A. W. Küchler, "A Comprehensive Method of Mapping Vegetation," *Annals*, Association of American Geographers, Vol. XLV, No. 4 (1955), pp. 404–15.

[8] A. W. Küchler, "Classification and Purpose in Vegetation Maps," *Geographical Review*, Vol. XLVI, No. 2 (1956), pp. 155–67.

[9] C. S. Christian and R. A. Perry, "The Systematic Description of Plant Communities by the Use of Symbols," *Journal of Ecology*, Vol. 41, No. 1 (1953), pp. 100–5; P. W. Richards, *op. cit.*; Pierre Dansereau, *op. cit.*, pp. 172–229.

on occasion also represent the typical species in their proper place within the community.

The principle of the vegetation profile is incorporated into the map and becomes the basis of its design through translation from the actual profiles found in nature to idealized linear transects, which form a solid tier one above the other, filling the space in the area to be mapped. Within the transect the form, size, and other characteristics of vegetation components are shown by conventionalized symbols arranged to reproduce approximately to scale the spatial relationships among them in the vertical and horizontal dimensions. The map thus shows only a limited set of transects of vegetation across the area considered. But the width of the space required for a complete and accurate vegetation transect is so slight that the tier may consist of a very large number of transects, and the accidental geometric patterns formed by the combinations of symbols within the transects emerge as an areal mosaic, much like an arbitrarily selected geometric design used for cartographic differentiation. This areal mosaic is of course composed of many different patterns, for each is made up of symbols arranged to represent concretely its unique vegetation type. On the other hand, because of this same feature and because the transects suggest continuous horizontal variation, the mosaic need not be composed of sharply delineated sectors but rather of intergrading patterns. The major pattern of the map reflects broad areal differences in vegetation, while the minor shows structural characteristics, and both may be read simultaneously. Relatively few symbols are necessary, and it is mainly the relationships among these that convey the desired information. The structural characteristics of the vegetation are read directly from the map at any point.

## III

The symbols employed to represent the vegetation components, and their arrangement in space, are designed to express the several diagnostic characteristics of any given community of plants in an orderly way, according to explicit principles of classification, and at the same time to preserve relationships of dimension, spatial position, and numerical proportion. The first requirement in designing such symbols is therefore the choice of distinctive signs whose size may be made to vary to scale without sacrificing their intelligibility or distorting the proportional relationships in the complex to be represented.

The selection of signs to be employed must correspond to the several categories of information regarding vegetation which will enable the user to distinguish among different kinds of communities and to infer directly from the map as much as possible about their characteristics. The signs should account for as many as possible of the following vegetation features:[10]

1. Height of plants
2. Leaf type (broadleaf, needleleaf, leafless)
3. Seasonal regime (evergreen, deciduous)
4. Gross life form (tree, with unbranched portion of trunk equal to or longer than branched portion; shrub, with unbranched portion of trunk very short or absent; herb, with no permanent woody trunk; fern; moss; and lichen)
5. Special life form (epiphyte, liane, leafless succulent, tufted or palm-like form, hummock)
6. Vertical spatial arrangement of plants
7. Horizontal spatial arrangement of plants
8. Proportions of different types of plants in the whole

The signs must be so designed that they can convey the necessary information as to these features clearly and unambiguously, but in the simplest possible way. A minimal number of different basic signs should be used. Simplicity of design is important both for the intelligibility of the map and for ease in drafting.

The signs chosen to represent the features listed are shown in Figure 1. In order to reproduce the size characteristics of plants, the heights of plants are grouped into a workable number of size classes and portrayed to scale. A set of from one to ten or more different size classes is established, and the dimensions of the symbols used to portray the plants form a regular series of gradations at a uniform interval of magnitude from smallest to largest size classes. The most convenient device for reproducing height relations is the use of a series of diameters for the signs graduated in millimeters. Resultant specifications

[10] *Cf.* Richards, Tansley, and Watt, *op. cit.*

for height classes in a given vegetation might be as follows:

| *Height of trees* | *Diameter of signs* |
|---|---|
| 200 feet | 6 mm. |
| 125–200 feet | 5 mm. |
| 90–125 feet | 4 mm. |
| 60– 90 feet | 3 mm. |
| 30– 60 feet | 2 mm. |
| < 30 feet | 1 mm. |

This is one of many possible height classifi-


FIG. 1. Basic symbols for structural vegetation mapping.

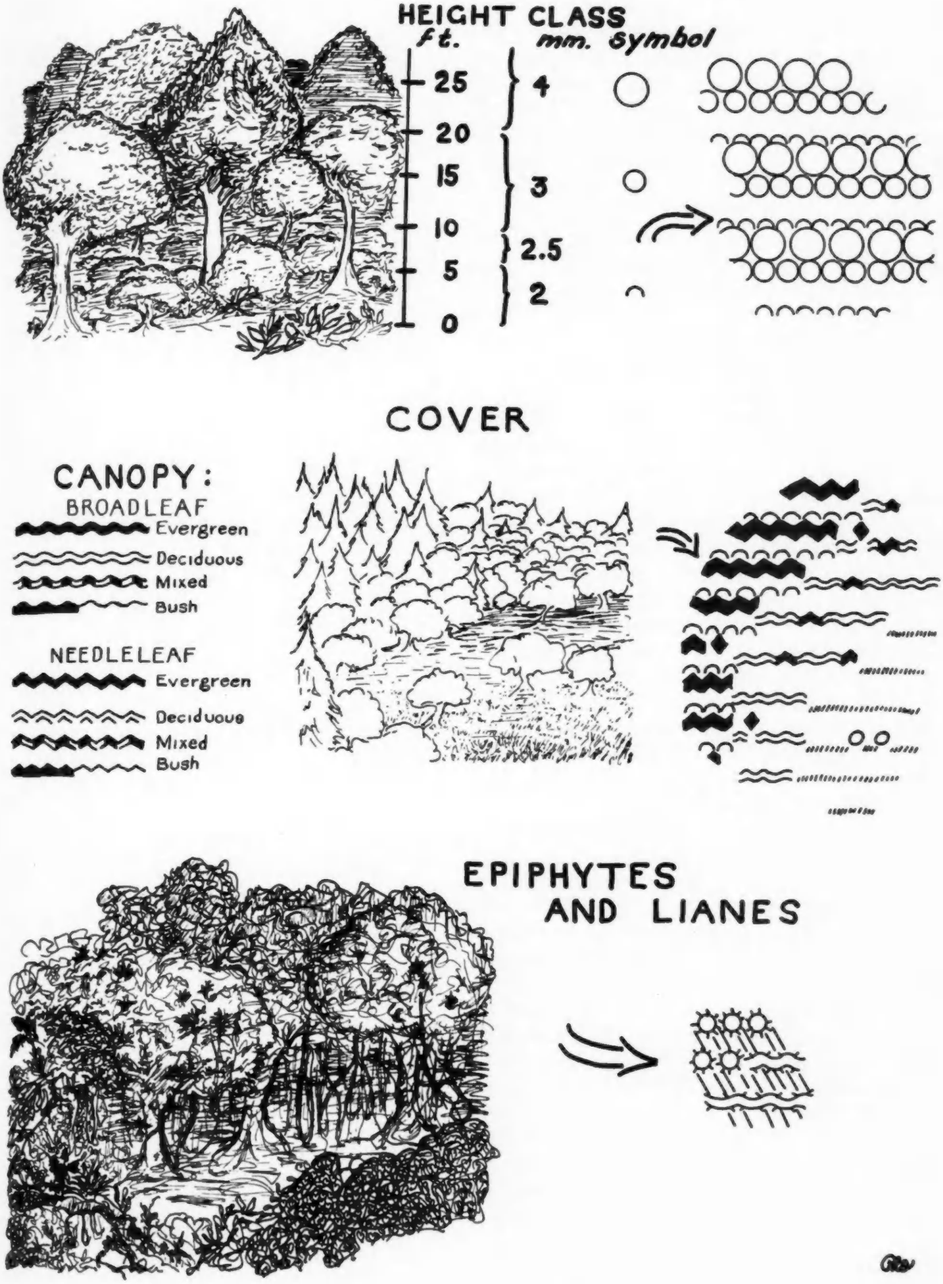


FIG. 2. Application of the standard symbols in mapping. Height is represented (above) by a scale of diameters chosen in accordance with observed groupings of plants by height ("layers"). The cover feature of vegetation is shown (center) by a combination of symbols into a continuous canopy symbol, where indicated. Special symbols are added (below) to the major symbols when appropriate.

cations. The number of classes, and thus of symbols used to portray them, will vary with the communities treated. In some cases it might be desirable to vary the class interval, as has been done here; this might be especially useful in treating herbs and bushes, whose height differences would not emerge clearly if they were treated on the same scale as the larger trees.

The representation of leaf type depends upon the use of a few simple geometric symbols, with circles or dots for broadleaf, diamonds for needleleaf, and an inverted U for leafless plants (*sensu lato*).

The seasonal regime of the plant is expressed by filling in the symbols in black or in color for evergreens, and leaving the symbols for deciduous plants blank.

Trees are shown as full circles, dots, or diamonds; shrubs are represented by half circles, half diamonds, etc., at ground level, and ferns by a special fern-like symbol; mosses and lichens are indicated by two levels of short dashes near ground level, or grouped around the symbols for plants on which they grow.

Special life forms demand particular symbols of their own. The epiphytes are shown as short linear protuberances on the symbols for other plants in the appropriate layer; lianes are long slanted lines in the proper space within and between tree layers; leafless succulents like the cacti and some of the euphorbias are represented by a combination of the evergreen and the leafless symbols at shrub level; palm-like and tufted forms are symbolized by an asterisk imitating their actual form.

The treatment of herbs differentiates grasses and other terrestrial monocotyledons, shown by short inclined parallel lines, from dicotyledonous herbs, which appear as an inclined Y symbol. Hummock plants are symbolized by a half-asterisk at ground level. Aquatics are given special treatment: a horizontal line at the base of the transect represents water, and in this the sedges and other standing plants appear as parallel slanted lines like the grass symbols, but transecting the water line; floating aquatics are shown as X's bisected by the water line.

Many of these symbols resemble those proposed by Dansereau,[11] but they are more simply conceived in order to allow for use at varying scales and for ready interpretation.

[11] Pierre Dansereau, *op. cit.*

## IV

The map is constructed by laying off profile bands across the entire surface to be used, the width of the bands being set by the scale of the map and the technical requirements for reduction and reproduction. The bands must allow space to accommodate the maximum number of different layers of plants or the maximum tree height within the whole area shown. Thus, if the tallest and most complex community to be shown on the map is composed of two tree layers at average heights of forty and seventy feet, respectively, the total of the diameters of the necessary symbols will be five millimeters, in the case of the sample schedule of diameters given above, and this might represent the required width of the band, which is uniform throughout the map.

Having constructed a full tier of profile bands or transects in the space to be mapped, the cartographer proceeds to fill in the symbols for plants in each band, following his prepared outline of the areal distribution and detailed structure and composition of the vegetation. It must be emphasized that this method in general relies on the portrayal of characteristics of individual trees through the use of corresponding individual and separate signs. The literal application of this principle, however, would require a symbol for each tree in the actual community, which is manifestly beyond the capabilities of any map except at a very large scale. The aggregate representation of a community must therefore depend upon some sort of abstraction which will preserve the numerical proportions among plants in different structural and floristic categories without the portrayal of every plant. The vegetation to be represented is accordingly generalized in the profile, and the numerical and spatial distribution of the conventional signs is such as to reproduce the proportions and arrangements among different types found in the actual community.

The layers of plants at different heights form in some cases a dense canopy in which all of the crowns of a certain tree level are everywhere touching, and in other cases a sparse distribution of isolated individual trees. In most communities the plants do not present an even frequency distribution among height classes but tend to cluster into a few separate levels with relatively open space above and below, forming strata or layers, the number,

position and density of which are among the chief diagnostic features of a vegetation. These layers are represented on the map by the concentration of the symbols in a few height zones within the profile, and, where a closed canopy is present, by a continuous band symbol.

In addition to the reproduction of this stratification, in which distinctive forms occur at particular heights, the map is capable of portraying the percentage distribution of various structural types in both horizontal and vertical dimensions. The feature of coverage as established by Braun-Blanquet[12] expresses the proportion of total crown cover provided by individuals of a particular species, structural type, or other category, and can be expressed through the observation of the desired percentage distribution in the allotment of symbols in line within the transect. Thus, in a tree stratum composed of 20 percent individuals of needleleaf evergreen and 80 percent broadleaf deciduous, every fifth symbol would be one representing needleleaf evergreen.

The important feature of smooth and gradual variation can be reproduced at larger scales for some types of vegetation by a corresponding manipulation of the spacing of symbols in a horizontal direction. This may avoid the embarrassing necessity, common in mapping continuously varying phenomena, of establishing artificial sharp boundaries in broad transition zones. All that need be recorded and reproduced is the tempo of the transition.

## V

The mapping principles outlined here should eventually make possible the construction of uniform vegetation maps for any and all parts of the world. Information from a variety of sources may be translated with little difficulty into a structural system and plotted on a map which employs a degree of detail measured by the limits of the least complete information for any area within its scope. The required information may be translated from existing vegetation maps. Sketches, photographs, and verbal descriptions offer other means of establishing structural characteristics. The most desirable information is of course that obtained from careful field inspection and plotted areally with the help of maps and aerial photographs, as pointed out by Küchler.[13]

The execution of a map demands painstaking work. It is laborious to construct the entire map by hand, although this gives the most pleasing aesthetic result. The use of circle- and square-templates is a workable alternative. In either case, the map should be drawn at a scale large enough to allow accurate drafting of the symbols, and then be reduced to the size desired. If a fine crowquill pen is used in drafting the symbols, the minimum diameter for symbols that can be reduced safely by photographic techniques is set by a resultant size on the reduced map of just above one millimeter.

The tedium of hand drafting of numerous small symbols is obviated by the use of prepared overlay patterns which can be made up in advance and reproduced photographically in any desired quantity. If overlays are used, however, it may be necessary to employ several different horizontal spacings to preserve the pattern of horizontal variation; otherwise transition areas may be drafted by hand.

The success of this approach to vegetation mapping depends upon the quality of the drafting work. If the symbols are accurately and neatly represented, they produce a regular and harmonious primary areal pattern, and the detail within the transects can be read correctly. If they are uneven and poorly drawn, the map is unsatisfactory for detail and its over-all appearance may be confusing.

A large part of cartography is invention. I propose the structural profile approach to vegetation mapping in this spirit, acknowledging its foundation upon previous work and recognizing that it will be subject to revision, improvement, and adaptation. It is submitted as a proposal for experimentation, not as a finished methodology.[14]

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[12] *Cf.* Küchler, "A Comprehensive Method of Mapping Vegetation," *op. cit.*

[13] *Ibid.*

[14] The author acknowledges his indebtedness to Professor A. W. Küchler for very helpful criticisms of the manuscript of this article.

# THE DISTRIBUTION OF MANUFACTURING IN TEXAS

TOM L. McKNIGHT

*University of California, Los Angeles*

IN recent years the southwestern part of the United States has undergone a marked industrial growth.[1] Much of this expansion has taken place in Texas, where manufactural employment has increased at 3½ times the national average in the last sixteen years. It is the purpose of this study to outline the present distribution of manufacturing in that state, with an emphasis upon relative as well as absolute significance. Where is the Texas manufacturing located? What types of manufacturing are characteristic? How important is manufacturing in the several areas of concentration? What is the basis of the development in the principal areas?

### THE ROLE OF TEXAS AS AN INDUSTRIAL STATE

Texas, primarily an agricultural and petroleum-producing state two decades ago, now is also an important producer of manufactured goods. By the end of 1955 more than half a million Texans were employed in manufacturing establishments, and the total is increasing by 25,000 to 30,000 each year.[2] Today Texas ranks twelfth among the states on the basis of industrial employment (see Table 1), with about 2.7 percent of the national total.[3] This figure stands in contrast to the 1.7 percent claimed by Texas in 1939, when the state ranked sixteenth in this category and employed only 166,400 workers.[4]

Manufacturing is now a leading employer in the state, exceeded only by retail trade and services among the traditional Census Bureau categories of employment (see Table 2). Approximately 18 percent of the nonagricultural employees in Texas work in factories. While such a portion is small when compared to Massachusetts' 38 percent, New York's 32 percent, Illinois' 37 percent, Michigan's 47 percent, or even California's 27 percent,[5] it nevertheless represents a notable change from the cattle-cotton-wheat-oil orientation that was characteristic until a few years ago. In 1940, for example, manufactural employment amounted to only 11½ percent of total nonagricultural employment.

[1] The five states of California, Arizona, New Mexico, Texas, and Oklahoma contained less than 7⅛ percent of the industrial workers of the United States in 1940, but this share had increased to nearly eleven percent by 1956, an absolute gain of more than one million employees.

[2] Texas Employment Commission, "Texas Labor Market," January, 1956, p. 4.

[3] Bureau of Labor Statistics, *Employment and Earnings*, March, 1956, Table A–6.

[4] *Census of Manufactures*, 1939, Vol. 3, p. 44.

[5] Bureau of Labor Statistics, *Ibid.*

TABLE 1.—MANUFACTURAL EMPLOYMENT IN THE LEADING STATES, DECEMBER, 1955[1]

| Rank | State | Number of employees | Percent of U. S. total |
|---|---|---|---|
| 1 | New York | 1,949,700 | 11.4 |
| 2 | Pennsylvania | 1,479,200 | 8.7 |
| 3 | Ohio | 1,385,200 | 8.1 |
| 4 | Illinois | 1,297,800 | 7.6 |
| 5 | Michigan | 1,178,500 | 6.9 |
| 6 | California | 1,113,700 | 6.5 |
| 7 | New Jersey | 812,300 | 4.8 |
| 8 | Massachusetts | 704,900 | 4.1 |
| 9 | Indiana | 636,200 | 3.7 |
| 10 | North Carolina | 466,700 | 2.7 |
| 11 | Wisconsin | 464,800 | 2.7 |
| 12 | TEXAS | 459,600 | 2.7 |
| 13 | Connecticut | 433,800 | 2.5 |
| 14 | Missouri | 391,700 | 2.3 |
| 15 | Georgia | 340,100 | 2.0 |
| 16 | Tennessee | 299,100 | 1.7 |
| 17 | Maryland | 263,200 | 1.5 |
| 18 | Virginia | 252,900 | 1.5 |
| 19 | Alabama | 240,400 | 1.4 |
| 20 | South Carolina | 230,700 | 1.4 |

[1] *Source:* Bureau of Labor Statistics, *Employment and Earnings*, March, 1956, Table A–6.

TABLE 2.—NONAGRICULTURAL EMPLOYMENT IN TEXAS, DECEMBER, 1955[1]

| Category | Number of employees | Percent of total |
|---|---|---|
| Retail trade | 633,200 | 22.3 |
| Services | 623,100 | 21.9 |
| MANUFACTURING | 509,800 | 17.9 |
| Transportation, communications, and utilities | 263,700 | 9.3 |
| Construction | 201,900 | 7.2 |
| Government | 183,300 | 6.4 |
| Wholesale trade | 169,300 | 5.9 |
| Domestics | 138,500 | 4.8 |
| Mining | 128,500 | 4.4 |
| Other | 4.100 | 0.1 |
| Total | 2,855,400 | 100.0 |

[1] *Source:* Unpublished figures of the Texas Employment Commission.

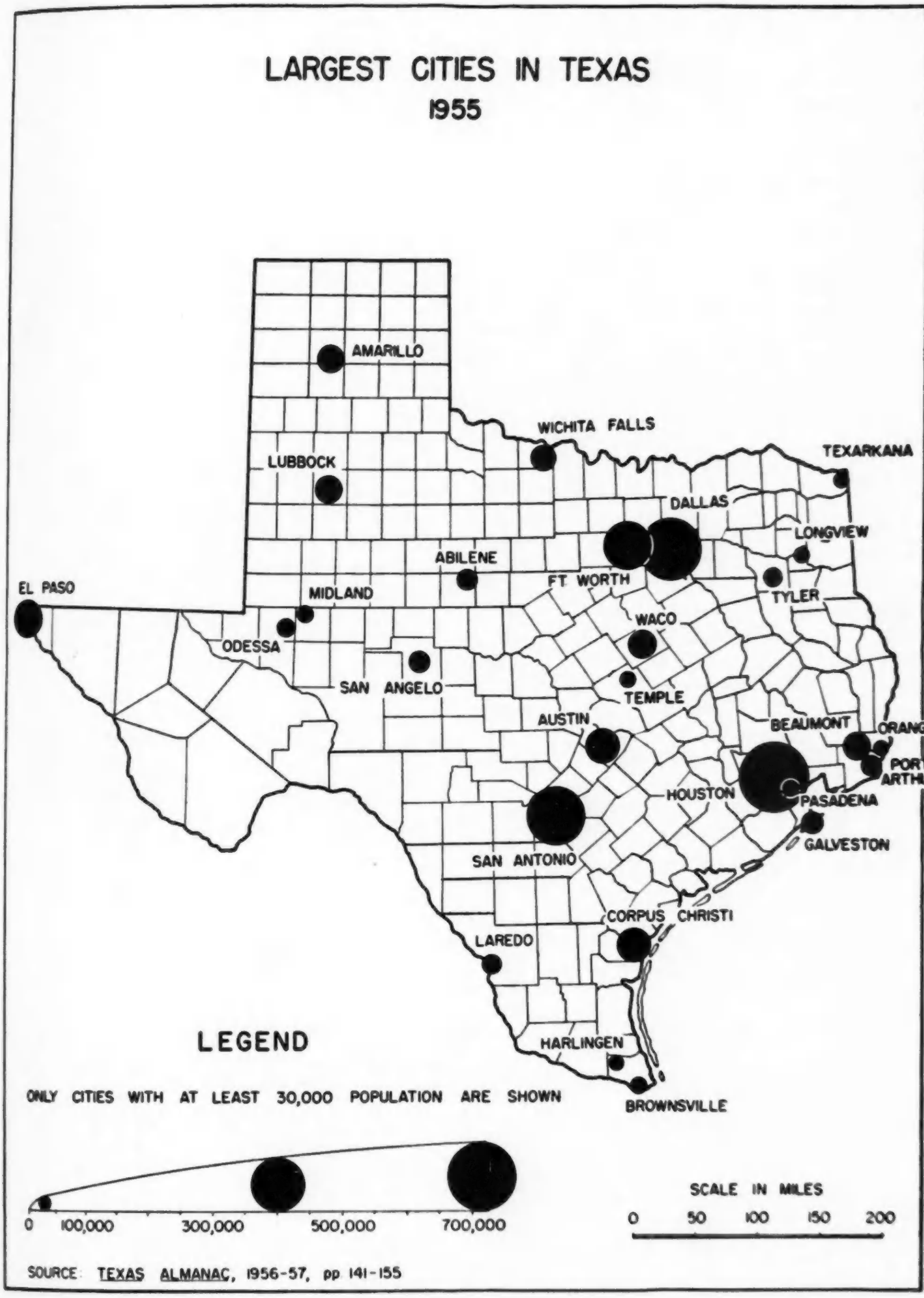

LARGEST CITIES IN TEXAS
1955
AMARILLO
WICHITA FALLS
TEXARKANA
LUBBOCK
DALLAS
LONGVIEW
ABILENE
FT WORTH
TYLER
EL PASO
MIDLAND
WACO
ODESSA
SAN ANGELO
TEMPLE
AUSTIN
BEAUMONT
ORANGE
PORT ARTHUR
HOUSTON
PASADENA
GALVESTON
SAN ANTONIO
CORPUS CHRISTI
LAREDO
LEGEND
ONLY CITIES WITH AT LEAST 30,000 POPULATION ARE SHOWN
HARLINGEN
BROWNSVILLE
0
100,000
300,000
500,000
700,000
SCALE IN MILES
0 50 100 150 200
SOURCE: TEXAS ALMANAC, 1956-57, pp 141-155

FIGURE 1

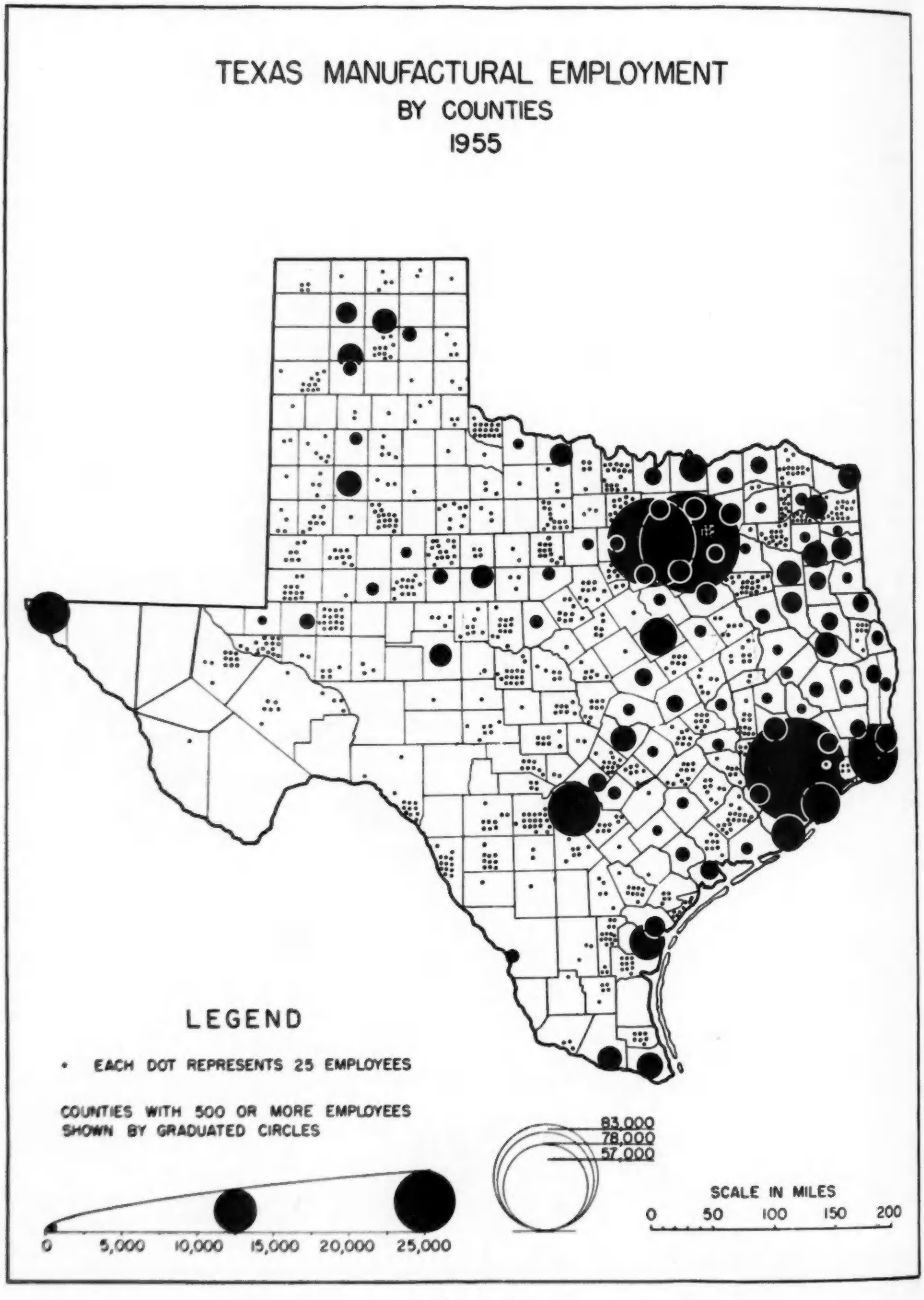

TEXAS MANUFACTURAL EMPLOYMENT
BY COUNTIES
1955
LEGEND
EACH DOT REPRESENTS 25 EMPLOYEES
COUNTIES WITH 500 OR MORE EMPLOYEES
SHOWN BY GRADUATED CIRCLES
0
5,000
10,000
15,000
20,000
25,000
83,000
78,000
57,000
SCALE IN MILES
0 50 100 150 200

FIGURE 2

MAPPING THE DISTRIBUTION OF MANUFACTURING

This paper presents four maps to demonstrate the distributional aspects of manufacturing in Texas. The first is for reference purposes. It permits a comparison of urbanization in Texas with the succeeding maps that portray industrial distribution. All of the cities with a population of 30,000 or more as of late 1955 are included.

Figure 2 shows the actual distribution of manufactural employment over the state on a county basis.[6] There are two major areas of rather compact concentration: (1) The leading zone consists of the Dallas-Fort Worth area, a concentrated node in north-central Texas. (2) The second major region comprises the eastern Gulf coast, featuring a western node dominated by Houston, and an eastern node seventy miles away dominated by Beaumont and Port Arthur. Two less concentrated, but nevertheless distinct regional associations may be discerned: (1) The fertile blackland prairies of central Texas stand out on the map from Denison and Sherman (Grayson County) near the Oklahoma border to San Antonio in south-central Texas. (2) Many of the counties of the East Texas "piney woods" region are also noticeable, although the pattern is a sporadic one. In addition to these principal groupings, some individual cities form less prominent nodes. Chief among these are Corpus Christi on the southern coast, El Paso in far west Texas, and Amarillo-Pampa-Borger in the Panhandle.

The purpose of Figure 3 is to demonstrate the relative importance of manufacturing in the various counties. This is done by showing the manufactural employment as a percentage of nonagricultural employment in each county. Once again the "piney woods" region is notable, although the counties that stand out most are not the same as the outstanding ones on the preceding map. Morris County in the extreme northeastern corner of the state is about two-thirds dependent on manufacturing, principally a result of the establishment of a large blast furnace and steel mill near Daingerfield. This is a much higher percentage than in any other county. Most of the other counties show a low percentage of industrialization, particularly in west and south Texas.

Figure 4 represents an attempt to synthesize the two preceding maps into one. The "indexes of industrialization" as used here were obtained by multiplying manufactural employment by the percentage that manufactural employment is of total nonagricultural employment. To cite two examples: Dallas County has 78,165 industrial workers, which number comprises 25.0 percent of the total nonagricultural employment of the county. When these two figures are multiplied, the result gives an index of industrialization of 19,541. Dallam County in the extreme northwest corner of the Panhandle has 128 industrial workers, which represent 5.0 percent of the total nonagricultural employ-

[6] On this map, as on Figure 4, the dots are located as closely as possible to their actual positions, rather than being distributed evenly or clustered in the center of the counties.

TABLE 3.—LEADING INDUSTRIAL COUNTIES OF TEXAS, BASED ON INDEXES OF INDUSTRIALIZATION, 1955

| Rank | County | Principal cities | Index of industrialization | Rank based on manufacturing employment only |
|---|---|---|---|---|
| 1 | Dallas | Dallas, Garland, Grand Prairie | 19,541 | 2 |
| 2 | Harris | Houston, Baytown, Pasadena | 19,174 | 1 |
| 3 | Tarrant | Fort Worth, Arlington | 17,332 | 3 |
| 4 | Jefferson | Beaumont, Port Arthur | 9,304 | 4 |
| 5 | Brazoria | Freeport, Angleton, Velasco | 3,213 | 9 |
| 6 | Galveston | Galveston, Texas City | 3,011 | 7 |
| 7 | Morris | Daingerfield | 2,868 | 20 |
| 8 | Bexar | San Antonio | 2,761 | 5 |
| 9 | Orange | Orange | 2,466 | 11 |
| 10 | El Paso | El Paso | 1,997 | 6 |
| 11 | Angelina | Lufkin | 1,845 | 16 |
| 12 | McLennan | Waco, McGregor | 1,622 | 8 |
| 13 | Hutchinson | Borger | 1,274 | 19 |
| 14 | Grayson | Sherman, Denison | 1,101 | 12 |
| 15 | Nueces | Corpus Christi, Robstown | 1,089 | 10 |

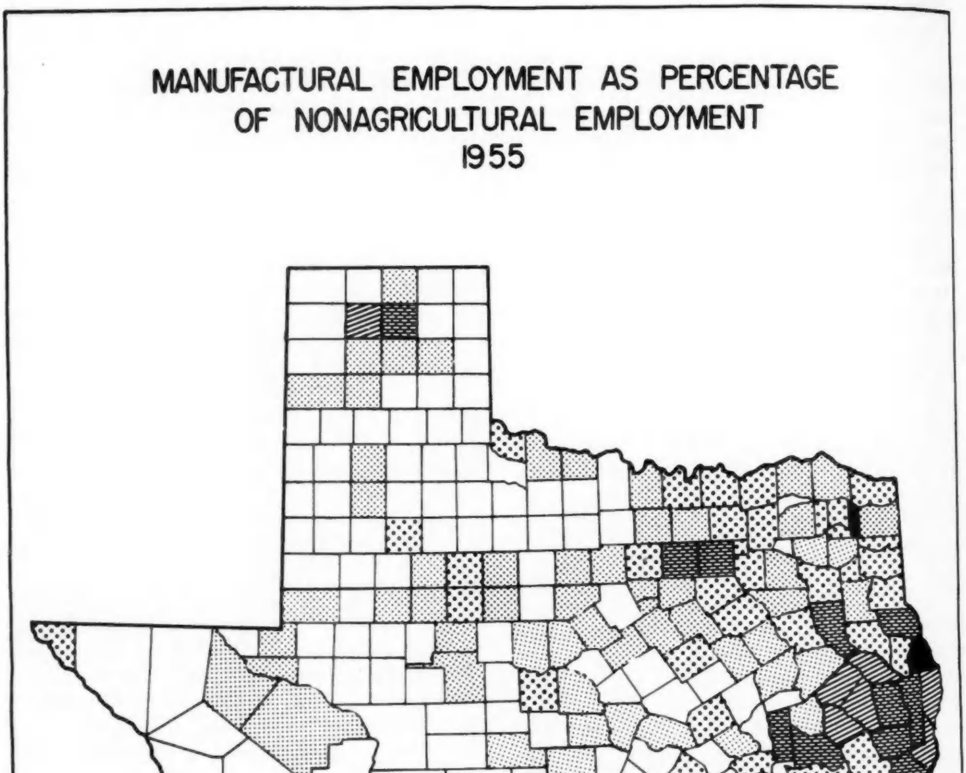

MANUFACTURAL EMPLOYMENT AS PERCENTAGE
OF NONAGRICULTURAL EMPLOYMENT
1955
LEGEND
LESS THAN 7.5%
7.5% TO 15%
15% TO 25%
25% TO 35%
35% TO 50%
MORE THAN 50%
SCALE IN MILES
0 50 100 150 200

FIGURE 3

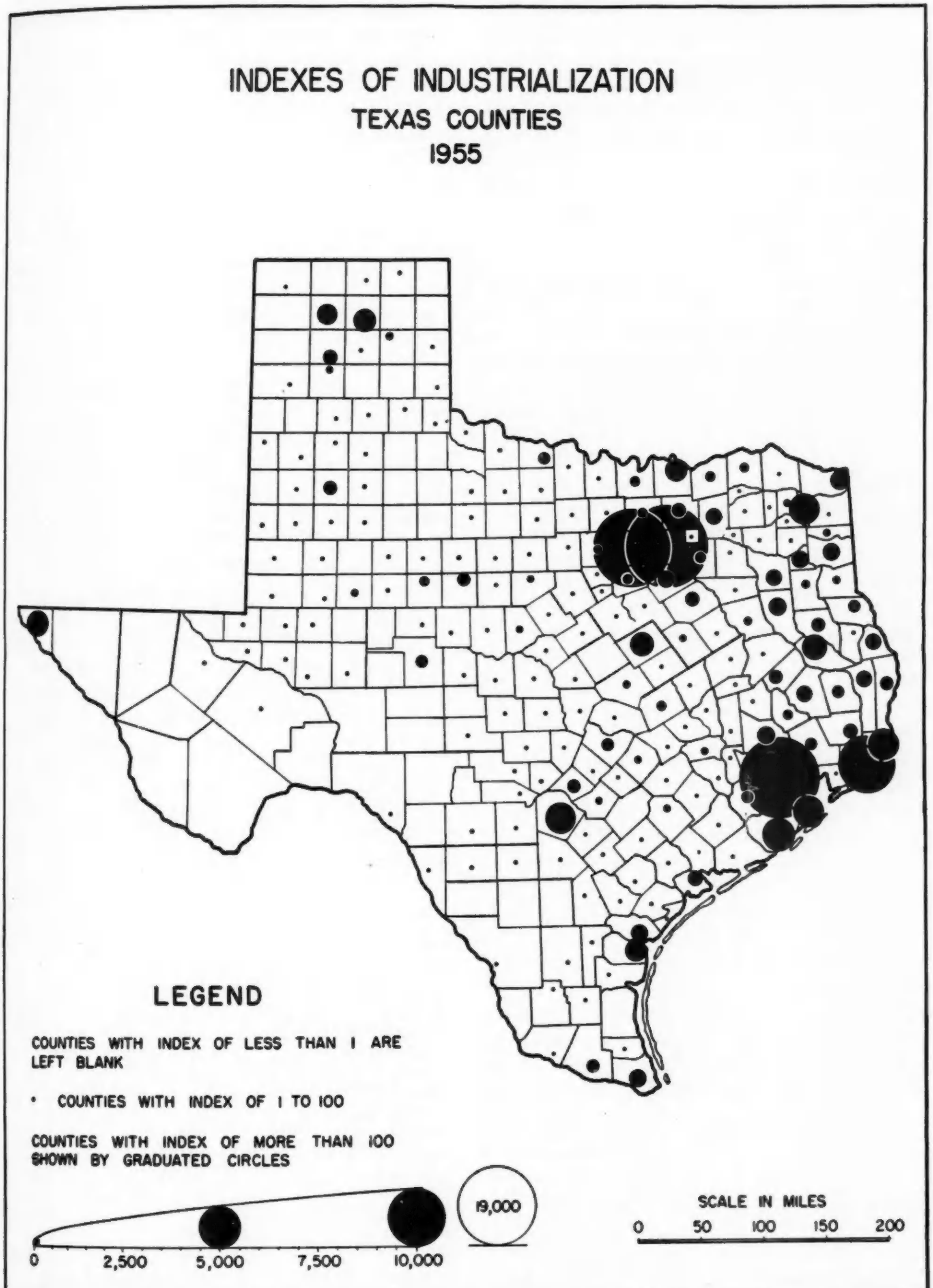

INDEXES OF INDUSTRIALIZATION
TEXAS COUNTIES
1955
LEGEND
COUNTIES WITH INDEX OF LESS THAN 1 ARE LEFT BLANK
• COUNTIES WITH INDEX OF 1 TO 100
COUNTIES WITH INDEX OF MORE THAN 100 SHOWN BY GRADUATED CIRCLES
19,000
0
2,500
5,000
7,500
10,000
SCALE IN MILES
0
50
100
150
200

Figure 4

ment, and yield an index of industrialization of 6. The author realizes that this method represents an oversimplification of a complex relationship, but feels that it is one method of arriving at a relatively simple synthesis of absolute and relative importance.[7] The pattern revealed by Figure 4 is not greatly dissimilar to that of Figure 2, but does differ in several respects. These differences are largely reflections of the relative importance of manufacturing in the various counties.

The two major concentrations (Dallas-Fort Worth and eastern Gulf coast) are still apparent, and their pre-eminence over the other areas is accentuated. However, the blackland prairie of central Texas that was easily discernible on Figure 2 fails to appear on Figure 4, largely because of the relative subordination of manufacturing to trade and services in those counties. The "piney woods" region of extreme east Texas is subdued but perceptible.

Some areas represented by large circles on Figure 2 show relative unimportance of manufacturing in the total economy of the county. Chief among these is San Antonio, which is only twelve percent industrialized, but notable deflation also occurred for El Paso, Waco, Corpus Christi, Austin, Lubbock, Abilene and San Angelo. On the other hand, some areas with relatively small absolute employment in manufacturing show up strongly on Figure 4 because of the relative importance of industry in the local economy. The extreme example is Morris County (Daingerfield), but also notable are Brazoria (Freeport, Velasco, Angleton) and Orange counties. The four major industrial counties, Harris (Houston), Dallas, Tarrant (Fort Worth), and Jefferson (Beaumont and Port Arthur), retain approximately the same stature on both maps, showing some balance. It is interesting to note that the circle representing Dallas on Figure 4 is actually larger than that for Houston. The implication, however, is somewhat misleading and points up the ticklish problem of trying to compare an area like Houston having industries heavily dependent on mechanical power with an area like Dallas having industries that utilize relatively more manpower and less mechanical power.

The regional pattern of Figure 4, then, is somewhat different from that of Figure 2. It is believed that the inclusion of some such concept as represented by Figure 4 is a significant addition to the understanding of the industrial geography of any area.

## THE PRINCIPAL INDUSTRIAL AREAS

*(1) Dallas–Fort Worth (27 percent of Texas' manufactural employment).* In Dallas and Tarrant counties a growing aircraft industry dominates an otherwise well-diversified picture. Although food processing (especially meat packing in Fort Worth) and apparel (particularly women's clothing in Dallas) have long been significant, the growth of aircraft manufacturing has overshadowed all other recent developments except the production of electrical machinery (see Table 4). The basis of industrialization in this two-county area essentially involves human and financial resources, but many of the basic industries (with the exception of aircraft production) are largely market-oriented. Dallas and Fort Worth are major wholesaling centers, their combined annual sales exceeding all but eight cities in the nation.[8] Thus factories located in

[7] For a more detailed treatment of a somewhat related concept, see John Thompson's discussion of "magnitude" and "intensity" ratings in "A New Method of Measuring Manufacturing," *Annals*, Association of American Geographers, Vol. XLV (Dec., 1955), pp. 416–36.

[8] *Sales Management*, May 10, 1956, p. 117.

TABLE 4.—INDUSTRIAL STRUCTURE OF THE DALLAS-FORT WORTH AREA, DECEMBER, 1955[1]

| Type of manufacturing | Number of employees | Percent of area's total manufacturing employment | Percent of state's employment in this type of manufacturing |
|---|---|---|---|
| Aircraft | 42,717 | 32 | 92 |
| Food processing | 22,733 | 17 | 28 |
| Apparel | 10,848 | 8 | 35 |
| Transportation equipment other than aircraft | 9,618 | 7 | 62 |
| Non-electrical machinery | 9,205 | 7 | 21 |
| Printing and publishing | 8,416 | 6 | 25 |
| Electrical machinery | 5,568 | 4 | 67 |
| Fabricated metals | 5,441 | 4 | 26 |
| Furniture | 4,577 | 3 | 38 |
| All other manufacturing | 16,242 | 12 | — |
| Total | 135,365 | 100 | 27 |

[1] Based on unpublished statistics of the Texas Employment Commission.

Dallas and Tarrant counties have a "hub" location for distribution to an extensive regional market. These advantages are particularly marked for producers of machinery (especially oil field and air conditioning equipment), fabricated metals, apparel, and processed or packaged foods.[9] The rapid population growth of most southwestern cities in recent years has added considerably to the labor force as well as the market potential. This factor is accentuated in the Dallas–Fort Worth area by the fact that many of the newcomers were trained in war plants that ceased operations in 1945, providing a skilled labor reservoir for plants that opened subsequently.[10] Special location factors affecting the five major aircraft plants of the area include the strategic inland situation, a benign year-round climate for test flights and outdoor maintenance, and availability of flat land adjacent to already-constructed airfields.[11]

*(2) Houston–Galveston (22 percent of Texas' manufactural employment).* Houston today is the fifteenth largest city in the nation, handles more tonnage than any other United States port except New York, and has more manufacturing than any other single city in the South or Gulf Southwest. In addition, the industrial complements of Baytown (located at the upper end of Galveston Bay), Texas City (between Baytown and Galveston), and Galveston (located on an offshore island) are near enough to be considered as portions of a single node. Although in general the industrial structure is diversified, emphasis is on the petroleum industry (see Table 5). The leading types of manufacturing in the area are machinery production (much of it oil-field machinery), petroleum refining, and petrochemical products (including synthetic rubber). This area typifies the advantages the Texas coastal plain has to offer heavy industry.[12] There is an abundant supply of several important mineral resources to use for raw materials (particularly petroleum, natural gas, sulfur, salt, and oyster shells), fuel and power resources are readily available and relatively inexpensive, there is ready access to cheap coastwise and overseas shipping (Galveston and Texas City have natural deepwater harbors, while Houston and Baytown have dredged accommodations for deep-draft vessels), and the rapidly-expanding population provides both labor supply and an increasing market.[13]

*(3) Beaumont–Port Arthur (7 percent of Texas' manufactural employment).* Situated in the extreme southeastern corner of the state in Jefferson and Orange counties are the four highly industrialized communities of Beaumont, Port Arthur, Orange, and Port Neches. This area combines plentiful mineral resources for raw materials and fuel with deep-water shipping facilities[14] and an abundant industrial water supply.[15] Jefferson County is probably the nation's leading center of petroleum refining, and the area contains considerable

TABLE 5.—INDUSTRIAL STRUCTURE OF THE HOUSTON–GALVESTON AREA, DECEMBER, 1955[1]

| Type of manufacturing | Number of employees | Percent of area's total manufacturing employment | Percent of state's employment in this type of manufacturing |
|---|---|---|---|
| Non-electrical machinery | 16,968 | 17 | 39 |
| Petroleum products | 15,814 | 16 | 27 |
| Chemicals | 14,831 | 15 | 33 |
| Food processing | 10,182 | 10 | 13 |
| Fabricated metals | 7,604 | 8 | 36 |
| Primary metals | 6,571 | 7 | 24 |
| Printing and publishing | 5,740 | 6 | 16 |
| All other manufacturing | 20,468 | 21 | — |
| Total | 98,278 | 100 | 22 |

[1] Based on unpublished statistics of the Texas Employment Commission.

[9] See Richard C. Henshaw and Alfred G. Dale, *An Economic Survey of Dallas County, Texas* (Austin: University of Texas, Bureau of Business Research, 1955), pp. 103–15.

[10] The prime example is the North American Aviation Company plant that employed 38,000 workers in 1944 at its Grand Prairie location but shut down entirely in 1945. See Tom McKnight, *Manufacturing in Dallas: A Study of Effects* (Austin, University of Texas, Bureau of Business Research, 1956), p. 63.

[11] See Tom McKnight, "Aircraft Manufacturing in Texas," *Southwestern Social Science Quarterly*, June, 1957, pp. 41–44.

[12] James J. Parsons, "Industrial Development in the Gulf South," *Geographical Review*, Vol. 40 (January 1950), p. 75.

[13] See Robert H. Ryan, "The Pattern of Texas Industry," *Texas Business Review*, Vol. 27 (May 1954), p. 3.

[14] Ernest H. Vaughan, "Texas' Sabine Area Ports," *Texas Business Review*, Vol. 27 (September, 1954), p. 4.

[15] Robert W. Williamson, "Industrial Growth in the Southwest," *Monthly Business Review*, Federal Reserve Bank of Dallas, Vol. 41 (Dec. 1, 1956), p. 179.

TABLE 6. — INDUSTRIAL STRUCTURE OF THE BEAUMONT–PORT ARTHUR AREA, DECEMBER, 1955[1]
(Jefferson and Orange counties)

| Type of manufacturing | Number of employees | Percent of area's total manufacturing employment | Percent of state's employment in this type of manufacturing |
|---|---|---|---|
| Petroleum products | 18,240 | 54 | 33 |
| Chemicals | 4,200 | 12 | 9 |
| Fabricated metals | 2,650 | 8 | 12 |
| Transportation equipment other than aircraft | 2,300 | 7 | 14 |
| Ordnance | 1,750 | 5 | 73 |
| Food processing | 1,600 | 5 | 2 |
| All other manufacturing | 3,100 | 9 | — |
| Total | 33,840 | 100 | 7 |

[1] Based on unpublished statistics of the Texas Employment Commission and the Orange Chamber of Commerce.

petrochemical production (see Table 6). Of secondary importance are rice milling, fabricated metals, and shipbuilding.

*(4) Corpus Christi (2 percent of Texas' manufactural employment).* Based on such primary activities as the growing of cotton and grain sorghums, ranching, and petroleum extraction, the Corpus Christi area contains several large industrial plants. Mostly clustered around the city's harbor and the head of Nueces Bay are facilities for petroleum refining, bauxite and alumina processing, petrochemicals production, and the elaboration of foodstuffs.

*(5) Pampa–Borger–Amarillo (2 percent of Texas' manufactural employment).* Situated near the center of the vast wheat-farming, cattle-ranching Panhandle is a loose assemblage of plants directly associated with the Panhandle gas field. Utilizing petroleum and natural gas for raw materials and natural gas for fuel, this area has developed significant production of refined petroleum products, chemicals of various types, and carbon black.

*(6) El Paso (2 percent of Texas' manufactural employment).* Oriented more toward Mexico and New Mexico than Texas, El Paso serves a far-flung market area and has a spacious but sparsely-populated hinterland. The manufacturing development is largely slanted toward this hinterland. The most distinctive plants are smelters for such nonferrous metals as lead, zinc, and copper, which were originally brought in from Mexican mines but now originate in a variety of states as well as Mexico. In terms of total employment the leading industry is the making of clothing, based largely on the inexpensive local female labor supply.

## CONCLUSION

It has been shown that the amount and type of industrial growth in Texas varies widely from place to place, just as the factors that support that growth vary. Industrial expansion may mean one thing on the Gulf Coast, but quite another in northeast Texas or in the Panhandle. Explanation of industrialization in Texas by reference to supplies of petroleum and natural gas or an expanding market or a tidewater location or an untapped labor reservoir are only valid when restricted to a more limited areal association. To generalize about the state as a whole is to over-simplify; only an analysis that recognizes and studies the diversity found in individual areas can contribute to a satisfactory understanding of the manufactural geography of Texas.[16]

[16] For those readers who might be interested in county-by-county tabulations of employment in Texas, the writer has prepared a mimeographed appendix. This appendix lists the manufactural employment, nonagricultural employment, manufactural employment as percentage of nonagricultural employment, and index of industrialization for each county in the state as of late 1955. A complimentary copy of the appendix may be obtained by writing to the author in care of the Department of Geography, University of California, Los Angeles.

# A METHOD FOR DESCRIBING QUANTITATIVELY THE CORRESPONDENCE OF GEOGRAPHICAL DISTRIBUTIONS[1]

ARTHUR H. ROBINSON AND REID A. BRYSON

*University of Wisconsin*

## THE PROBLEM OF CARTOGRAPHIC CORRELATION

THE subject to be considered in this paper is the development of a logically sound and easily applied method by means of which one may quantitatively describe and map, for an area, the manner in which the continuous variations within one class of phenomena correspond to the variations within another class. Nothing is more fundamental in geographical research than the recognition and description of similarities and differences in cultural and physical behavior from place to place. Although this concept of spatial association is central to the science of geography, the techniques presently employed to recognize and describe such relationships are often somewhat less than rigorous. A recent monograph clearly states the problem and the need for methods to solve it:

> It seems clear that geographic investigation is concerned with discovering and describing areal variations in the occurrence of phenomena on the earth's surface, and also with the search for other areally associated factors that may help to explain the observed distributions. In all such cases, questions are bound to arise as to the degree of association that exists between two (or more) phenomena. Areal association is indicated when a variation from place to place in the occurrence of one variable is accompanied by a similar place-to-place variation in the occurrence of another.
>
> In geographic research, areal associations in the occurrence of related phenomena (such as wheat yields and rainfall) have often been discovered by comparing maps of the distributions of those phenomena; and the resulting generalizations have usually taken a form such as, "In this region, there is a tendency for wheat yields to decrease as rainfall decreases." Vague generalizations such as these leave much to be desired, but they have been extremely useful in teaching and explaining areal variations in land-use patterns. Many associations, however, are not so clearly discernible as the wheat–rainfall association to which we have just referred. In those situations in which associations are less clearly defined, it has often been difficult to secure agreement even among competent professional geographers as to the degree, or even the existence, of such associations. Under these circumstances, it is impossible to escape the conclusion that these types of generalizations would have more value if they could be quantified. If some objective, quantified measure of association could be applied that would make such expressions as "slight tendency" or "strong tendency" more precise, it appears that the advancement of geographic analysis would be expedited materially.[2]

A number of geographical studies have employed ordinary statistical procedures to describe the association that exists between the attributes of a series of individuals. For example, the individuals may be years and the attributes rainfall and corn yield at a given place. By pairing the attributes one can calculate the ordinary correlation coefficient, which is a kind of index of the degree of average correspondence in the time change of the two variables for the particular years in question. The relationship can also be described by a regression equation which expresses how the two series have covaried through *time*; that is, one can conclude, all other factors remaining constant, that, on the average, given so much rainfall one could expect so much corn. The areal distribution of correlation coefficients over area may also be instructive, as has been shown by several studies. Rose has suggested the use of the term "isocorrelates" for the isopleths employed to describe the pattern.[3] Foster correlated annual rainfall at Omaha with 27 other stations

[1] This study was supported by the Graduate School of the University of Wisconsin. While the senior author was working on the cartographic problem of correlating distribution maps by simple procedures with considerable assistance from Professor Bryson of the Meteorology Department, the latter was engaged in a study involving the use of orthogonal polynomials and machine computing methods to describe in numerical terms the distribution of meteorological data over area. Although the aims of the two studies were very different, the statistical concepts involved are fundamentally similar. Consequently they decided to issue a joint report. The authors express their appreciation to James F. Lahey who carried out the machine computations necessary for the last example (Table 1).

[2] Harold H. McCarty, John C. Hook, and Duane S. Knos, *The Measurement of Association in Industrial Geography* (Iowa City: State University of Iowa, 1956), p. 20. Pages 20–53 contain an excellent summary of presently available techniques as well as suggestions for methods of measuring some other aspects of areal association.

[3] John K. Rose, "Corn Yields and Climate in the Corn Belt," *Geographical Review*, Vol. 26 (1936), pp. 88–102.

within about 500 miles.[4] Stidd plotted the correlation of Tennessee Valley rainfall with meteorological variables at a number of points in the United States.[5] The resulting charts show surprisingly smooth patterns of variation which suggests that even correlations which are too small to be statistically "significant" nevertheless may play an important role in determining a *pattern* of correlation.

The problem becomes somewhat different when the individuals become *place* instead of time. Here also there have been some previous studies. Fisher illustrates the use of regression equations in a problem having to do with rainfall, position, and altitude.[6] Brooks and Carruthers refer to some of the problems involved in the correlation of spatial factors.[7] Earlier, Mowrer calculated the coefficient of correlation of two distributions over area by measuring the areas of paired superimposed isopleths and used the resulting readings as frequencies.[8] It should be noted that his purpose was only to test whether the isopleth map was a reasonably faithful description of a distribution. He did this by comparing the coefficient arrived at with one derived from unmapped data, and he went on to suggest that such an isopleth map would be useful for "graphic correlation," i.e. visual comparison.

Naturally when one is comparing two distributions he would like a descriptive measure of the degree of similarity in the variations from place to place of the two distributions; for this the ordinary correlation coefficient may be employed, as indicated above. In such an instance, however, the concern is with changes in two dimensions (space) instead of only one (time), and consequently the single summary index does not reveal anything about the *areal distribution* of the correspondence. In addition, therefore, one would like somehow to *map* the spatial covariation so that relative departures from correspondence may also be located. It is the relative amount and direction of this, at different points on the map, that one wishes to know. This may well be more significant in geographical research than merely a summary index of the degree of correlation. Insofar as is known, mention of attempts to solve this particular aspect of the geographer's fundamental problem of spatial correlation has not appeared in the geographical literature until recently.[9]

## SOME BASIC CONCEPTS AND ASSUMPTIONS

The proposed method will be illustrated by using two representative continuous distributions and the isoline maps prepared from them as examples to be compared. Before describing the method, however, it will be necessary to review briefly the general concept of the isoline, since the numerical and spatial assumptions on which such maps are based are of some importance in the method of comparison here suggested. It will also be helpful for the reader to think in terms of simple three-dimensional space. Any position in earthly space can be located with reference to three coordinates: the ordinary $x$ and $y$ coordinates of the horizontal "plane" and the $z$ coordinate perpendicular to the horizontal. For example, any point on the irregular surface of the earth can be expressed in terms of its longitude ($x$), its latitude ($y$), and its elevation above some datum ($z$). Contours result from passing planes of given $z$ values through the surface parallel to both $x$ and $y$. A number of other familiar derivatives are computed from the three coordinate values. For example, land slope or gradient is the rate of change of $z$ with change in $x$ and $y$; if $z$ is made atmospheric temperature or pressure instead of elevation, temperature or pressure gradients may be computed, and so on.

Isopleths and isarithms, although well known, are not commonly thought of as the "contours" which describe the topography of

[4] Edgar E. Foster, "A Climatic Discontinuity in the Areal Correlation of Annual Precipitation in the Middle West," *Bulletin of the American Meteorological Society*, Vol. 25, No. 7 (1944), pp. 299–306. The pattern of correlation in this case showed that stations within the "prairie peninsula" core correlated with each other better than with stations outside that region, even though they were farther apart. Qualitatively, the shape of the correlation isopleths fits the "prairie peninsula" surprisingly well.

[5] C. K. Stidd, "The Use of Correlation Fields in Relating Precipitation to Circulation," *Journal of Meteorology*, Vol. 11, No. 3 (1954), pp. 202–13.

[6] R. A. Fisher, *Statistical Methods for Research Workers* (12th ed; New York: Hafner Publishing Co., 1954), p. 160 ff.

[7] C. E. P. Brooks and N. Carruthers, *Handbook of Statistical Methods in Meteorology* (London: Her Majesty's Stationery Office, 1953), pp. 226–28.

[8] E. R. Mowrer, "The Isometric Map as a Technique of Social Research," *American Journal of Sociology*, Vol. 44 (1938), pp. 86–96.

[9] Arthur H. Robinson, "A Method for Expressing Quantitatively the Correspondence of Mapped Distributions" (abstract), *Annals*, Association of American Geographers, Vol. 46 (1956), pp. 270–71, and McCarty, Hook, and Knos, *op. cit.*

an *assumed* three-dimensional surface. This surface is developed as follows: One first plots at selected $x$ and $y$ locations on a map some numbers, for example, population density. Then, in theory, there is erected at each location, i.e., control point, a vertical column proportional in height to the number, the $z$ coordinate, according to some scale, e.g., persons per square mile. Next, still in theory, the spaces between the columns are filled and a continuous $z$ surface is created, ordinarily by linear interpolation. The resulting "statistical surface" is theoretically the same as the surface of a topographic model.[10] It differs, however, in one fundamental respect, namely, that the $z$ values (the vertical scale) have no relation whatever with the $x$ and $y$ values; they are numbers which represent population density and therefore have no natural dimensional reality. Herein lies one element of the problem: there is, at present, no way in terms of the $x$ and $y$ relationships of the earth surface to describe the magnitude of the ups and downs of the $z$ surface, since both the "elevations" of points and the "slopes" between points are derived from an entirely arbitrary dimensional scale and bear no relation to horizontal distance. A series of horizontal planes passed through such a statistical surface provide isarithms or "contours."[11] It is important also to realize that the vertical, or $z$, scale of the statistical surface or model can be changed without changing the $x$ and $y$ positions of its isarithms; all that is necessary is that the chosen isarithmic values bear a constant relationship to whatever $z$ scale is used.[12] It is this fact that makes it possible to compare two isarithmic maps (regardless of the kinds of numbers involved in their construction) when the vertical scale of one distribution is transformed in a way that makes it comparable with the vertical scale of the other.

If a second statistical surface formed from other data were prepared for the same area, e.g., average annual precipitation, it could vary from exact correspondence with the first surface (complete positive correlation) through various degrees of similarity or dissimilarity to an exact mirror image surface (complete negative correlation). High positive correlation would show many high spots on the one surface to be high on the other. High negative correlation would mean the reverse, i.e., many of the high spots on one would be low spots on the other.

If the two surfaces were formed of thin plastic and their vertical scales somehow brought into accord, then if they were perfectly correlated positively they would fit snugly on top of one another; if negatively, the mirror image of one would fit the other. Since the degree of coincidence between two such surfaces would rarely reach perfection, the problem is to locate, to express in quantitative terms, and to symbolize in some fashion the areas where the two surfaces do and do not "fit" one another. Such an analysis of the relation between the two surfaces would present the geographer with what might be called ready-made hypotheses to be tested—and with many questions: What accounts for the demonstrated coincidence? Is it a cause-and-effect relationship or are the two variables dependent upon still another to which they both react? What different factors are involved in different areas? The list of such questions is long and aims at the heart of the geographers' problem — the explanation of, and the recognition of the principles involved in, differences from place to place.

It is possible to measure and map the relationship between two such statistical surfaces. The procedure involves merely a combination of well-known and easily applied cartographic and statistical processes. The general method may be applied in several ways and with different scales of detail.

### THE GENERAL METHOD OF CARTOGRAPHIC CORRELATION

For the purpose of illustrating the method and the procedures involved in applying it

[10] There are a great many sources of error inherent in the isarithmic map, such as the location of the control points, the validity of the average employed, the kinds of error involved in its derivation, and the manner in which the positions of the isarithms are determined through interpolation. A discussion of these is not appropriate here, and the maps and theoretical statistical sufaces subsequently employed are assumed to reflect truly the actual variations over area of the given quantities.

[11] Contours of a population density surface are more properly called isopleths since no point on such a surface can have an actual value, for the very definition of the $z$ values involves area.

[12] For example, on a rainfall map one may change inches to millimeters or divide all values by any given number; the numbers of the $z$ scale change and the range changes, but the isarithms remain in position. Of course, their numerical values will change.

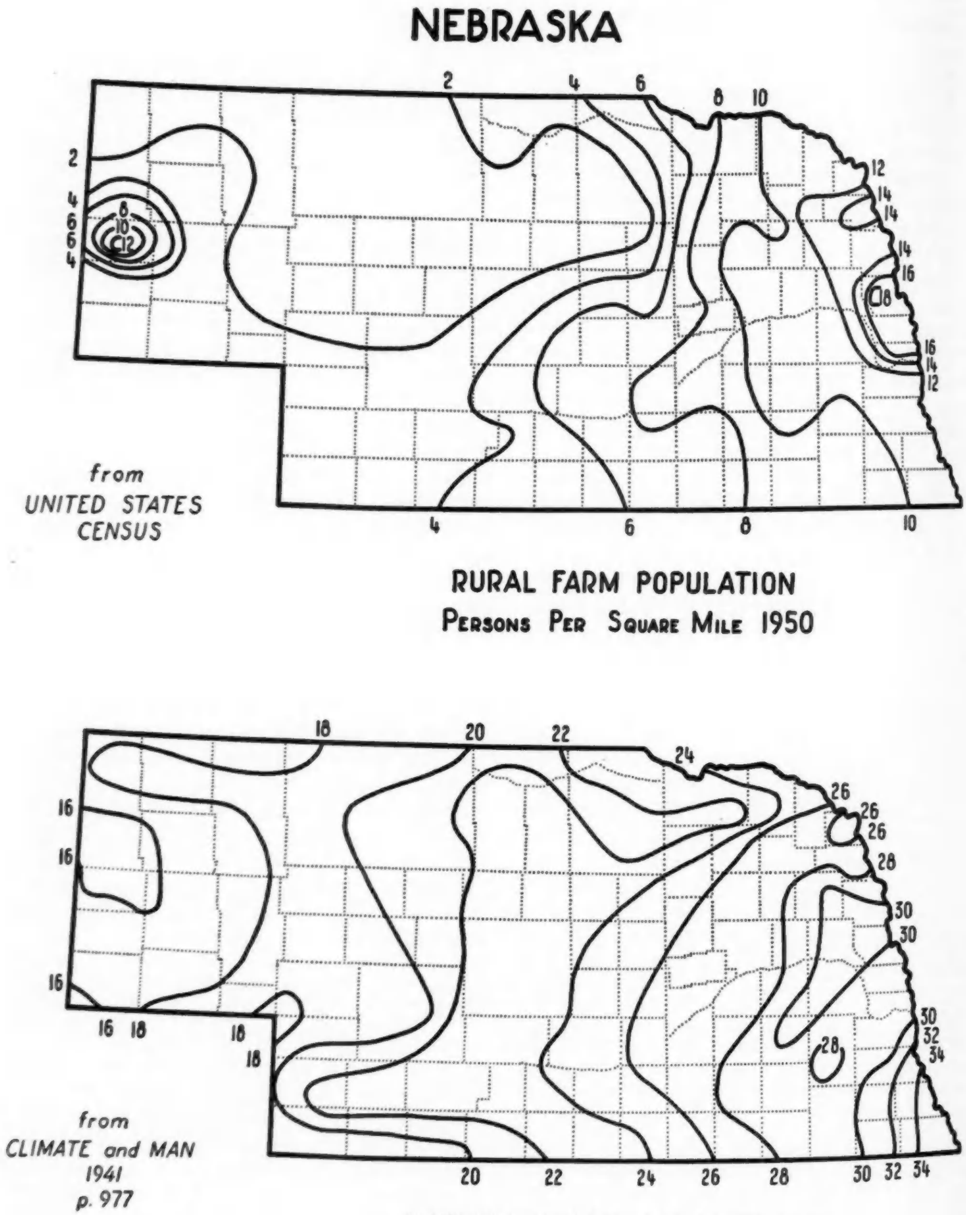



FIG. 1. The two maps upon which the demonstration of the method is based. The precipitation map was copied from *Climate and Man;* the population map was prepared from county data in the 1950 United States census.

to a particular problem, the following two distributions for the state of Nebraska are employed:

1. Figure 1 (top). *Density of Rural Farm Population.* The values were computed from county data in the *1950 United States Census of Population.* Values were rounded off to the nearest whole number, control points were located near the centers of the counties, and the isopleths were interpolated linearly to an interval of two persons per square mile. In the subsequent discussion, values of persons per square mile derived from this map will be designated as $D$ (density).
2. Figure 1 (bottom). *Average Annual Precipitation,* from *Climate and Man,* 1941 Yearbook of Agriculture. The isohyets are those on the map on p. 977. In the subsequent discussion, values of inches derived from this map will be designated as $P$ (precipitation).

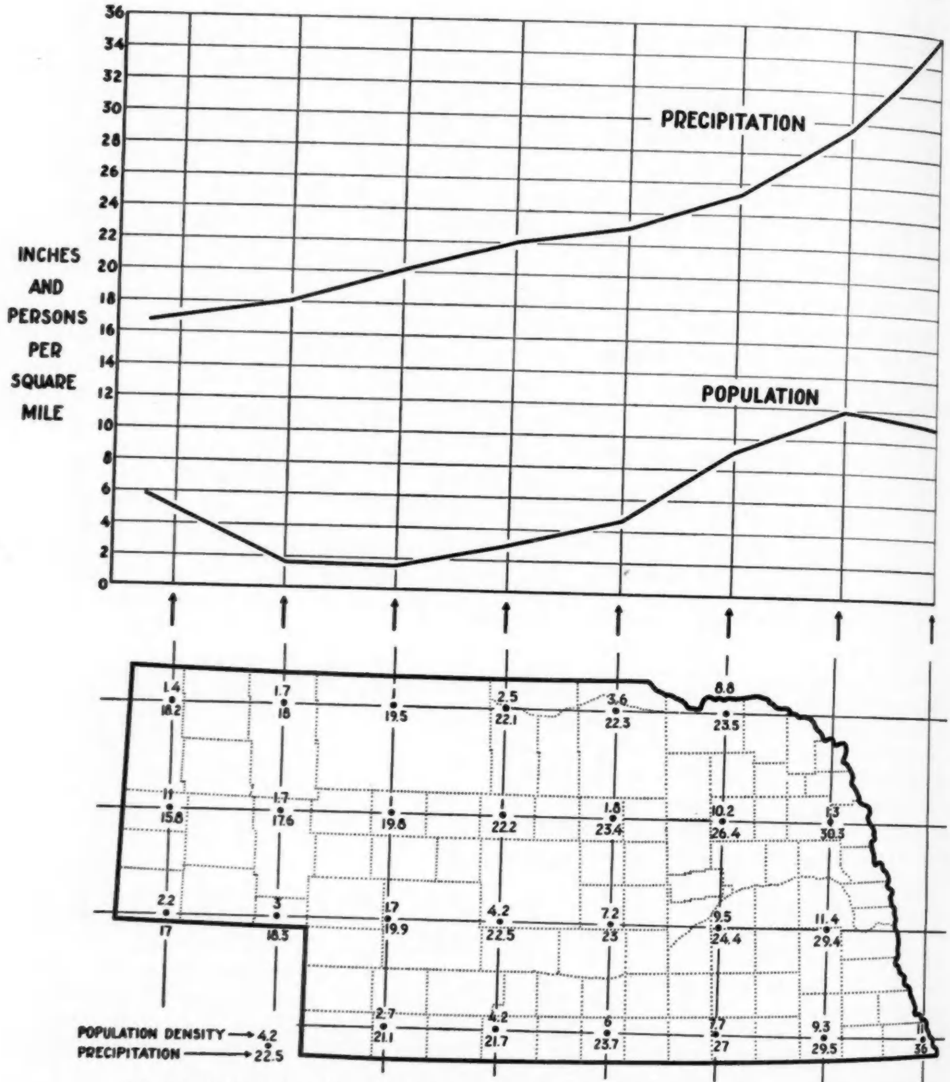
When the two maps are compared visually it will be seen that population density decreases westward as precipitation decreases. Also apparent are what seem to be departures from this general relationship, as for example in far western Nebraska in the Scotts Bluff area. To describe the general relationship in any quantitative terms, or to map the distribution of varying degrees of correspondence between the two maps would, however, be impossible from visual inspection alone. The major problems involved in a quantitative comparison of the maps derived from the two sets of data are the facts that (1) the two variables, $P$ and $D$, are in different ranges of numbers, and (2) the numbers refer to seemingly incomparable concepts: persons per square mile on the one hand and inches of precipitation on the other.

In order to illustrate the first of these difficulties Figure 2 has been prepared. A regular grid has been placed over the map, and at each intersection of the grid the $z$ values of the continuous surfaces of $D$ (density) and of $P$ (precipitation) have been determined by interpolation. Since the $x$ and $y$ position of each $D$ and $P$ value at a point is identical, any concern with their comparability in those two dimensions is removed. Each north–south column of grid values for each distribution has been separately averaged, and these column averages have been plotted on the graph at the top and joined with straight lines. The ordinates extend far enough to include both ranges of $z$ values, and the abscissas are simply evenly-spaced $x$ positions (east-west). The sole purpose of these two crude "average east–west profiles" is to illustrate the problem which arises because two different scales of measurement are employed.

In order to measure the relationship between two variables expressed as numbers it is rather obviously necessary that the two scales be made comparable. This can be done in two ways: (1) by expressing both series in terms independent of the scales of measurement used for either one, or (2) by transforming one series to the scale used for the other. The first of these transformations is called normalizing the data. It is accomplished by expressing each number of one series as a departure from the mean of the series and then dividing each departure by the standard deviation of the series. In symbolic terms any given $z$ value of density $(D)$ is transformed to a normalized value $(D_n)$ by $D_n = (D - \overline{D})/\sigma_d$, in which $\overline{D}$ is the mean of $D$ and $\sigma_d$ is the standard deviation of $D$. The same is then done for the other scale.[13] The numbers of the normalized scale will bear the same relationship to one another that they did before normalizing. Unfortunately, however, the numbers of a normalized series, being merely numbers expressing departures from the mean in units of the standard deviation, do not have any obvious meaning in terms of the originial quantities. This inconvenience can be obviated, and essentially the same result can be accomplished by expressing one series in terms of the other. This will illustrate the process more clearly, and it has the further advantage of retaining the numbers in a meaningful form. How this may be done will be explained below.

Assuming, for the moment, that both the $D$ and $P$ scales have been made comparable by normalizing the numbers of which they are composed, the two series cannot yet be compared properly unless the relationship between them is known. One should not employ simple averages. For example, it is clear even from visual inspection that as the average annual precipitation decreases westward

[13] See Paul G. Hoel, *Introduction to Mathematical Statistics* (2d ed; New York: John Wiley and Sons, Inc., 1954), pp. 117–19.




DIAGRAMMATIC E-W PROFILES OF NEBRASKA'S FARM POPULATION DENSITY AND ANNUAL PRECIPITATION FROM AVERAGES OF N-S GRID VALUES

FIG. 2. Each grid-point pair of values (average annual precipitation above, and rural farm population density below) on the bottom map is derived by interpolation from the two maps in Figure 1. Each north-south column of grid-point values on the map is averaged and these averages are plotted on the graph at the top; the lines which result when these averages are joined may be considered as generalized east-west "profiles."

across Nebraska there is, in some degree, a corresponding decrease in population density. To map departures merely from the state mean for each series and then to compare the values at various points with these state averages would likely result in relatively meaningless numbers. The reason for this can be easily illustrated by turning our attention to

eastern Nebraska where both annual precipitation and population density are above average; but by how much requires calculation. The average rural farm population density in Nebraska is approximately 5 persons per square mile and the average annual precipitation is about 22 inches. Saunders County in central eastern Nebraska has 11 rural persons per square mile and annually receives about 26 inches of precipitation. Therefore, it exceeds the state averages by 6 persons per square mile and 4 inches of annual precipitation, or, to state it another way, it exceeds the averages of population and precipitation by the seemingly rather large amounts of 120 percent and 18 percent, respectively. No matter how these numbers may be manipulated they do not tell us much if anything, for they do not take into account the obvious fact that as precipitation increases so does population. Instead, the significant fact against which we would like to compare Saunders County is the rate at which population changes with change in precipitation in Nebraska. It may turn out that Saunders County, in spite of its impressive population of 120 percent above the state average, is actually not far from what could be expected considering the change in precipitation amount. Instead, then, it is necessary to derive and describe in some reasonable fashion the *relationship* between the two distributions, and then express the comparisons of different places as departures from this relationship. In other words, how do the variations in population correspond to the variations in precipitation?

For this the regression of population on precipitation may be employed. Figure 3 shows a scatter diagram of the original values of the paired $P$ and $D$ values obtained from each of the intersections of the grid employed in Figure 2. These are plotted on a graph with a $Y$ axis of population and an $X$ axis of precipitation. The straight line of best fit shows the linear relationship between the two series of numbers. This is an ordinary regression line whose position and slope may be expressed by the general linear equation $Y = a + bX$. In a linear regression equation the coefficient $a$ is the $Y$ intercept of the line and $b$ is the slope. The values of $a$ and $b$ are calculated from the paired $X$ and $Y$ values, obtained in this case from the 26 grid intersections in Figure 2, i.e., $X = P$ and $Y = D$.[14]

The function of the regression equation is illustrated in the graph above the scatter diagram in Figure 3. On this graph the two solid lines are the same as those in Figure 2, but there has been added a dashed line. This is the original precipitation profile, which appears at the top, expressed with a different vertical scale. It has been adjusted by means of the regression equation so that the series of 26 average annual precipitation values now has the same mean and standard deviation as the series of population density values. The regression equation has merely been entered with actual $P$ values to give comparable population values ($D_c$), i.e., $D_c = -7.939 + 0.5826P$ (the subscript $c$ in $D_c$ stands for "computed"). Thus, for example, according to the relationship derived from this sample, we may "expect" a place in Nebraska that has 20 inches of average annual precipitation to have a rural farm population density of 3.7 persons per square mile ($-7.939 + 0.5826 \times$

[14] The computation is a relatively simple operation involving only arithmetic; machine computation methods may of course be employed if the sizes of the sums are likely to get out of hand. If original values are employed, the general formulae are:

$$a = \frac{\Sigma X^2 \cdot \Sigma Y - \Sigma X \cdot \Sigma XY}{N \cdot \Sigma X^2 - (\Sigma X)^2}$$

$$b = \frac{N \cdot \Sigma XY - \Sigma X \cdot \Sigma Y}{N \cdot \Sigma X^2 - (\Sigma X)^2}$$

$X$ = independent variable, $Y$ = dependent variable, $N$ = the number of pairs, and $\Sigma$ is the summation sign. When actual values of $P$ and $D$ are substituted for $X$ and $Y$ in the above formulae, the computations are:

$\Sigma X = 592.6$ $\quad$ $\Sigma Y = 138.8$
$\Sigma X^2 = 14{,}068.2$ $\quad$ $\Sigma XY = 3{,}490.7$
$(\Sigma X)^2 = 351{,}174.8$ $\quad$ $N = 26$

$$a = \frac{14{,}068.2 \times 138.8 - 592.6 \times 3{,}490.7}{26 \times 14{,}068.2 - 351{,}174.8} = -7.939$$

$$b = \frac{26 \times 3{,}490.7 - 592.6 \times 138.8}{26 \times 14{,}068.2 - 351{,}174.8} = 0.5826$$

The values of $a$ and $b$ obtained from this small sample are probably relatively crude. The sample was deliberately made small for illustrative purposes, and the points chosen so as to have a convenient grid from which to construct the "average east–west profile" employed in Figure 2.

There are other ways of determining the values of $a$ and $b$; the section on regression in any good statistics textbook will provide directions. Those with no familiarity with statistical methods will find W. A. Neiswanger, *Elementary Statistical Methods* (New York, 1948) especially easy to follow.

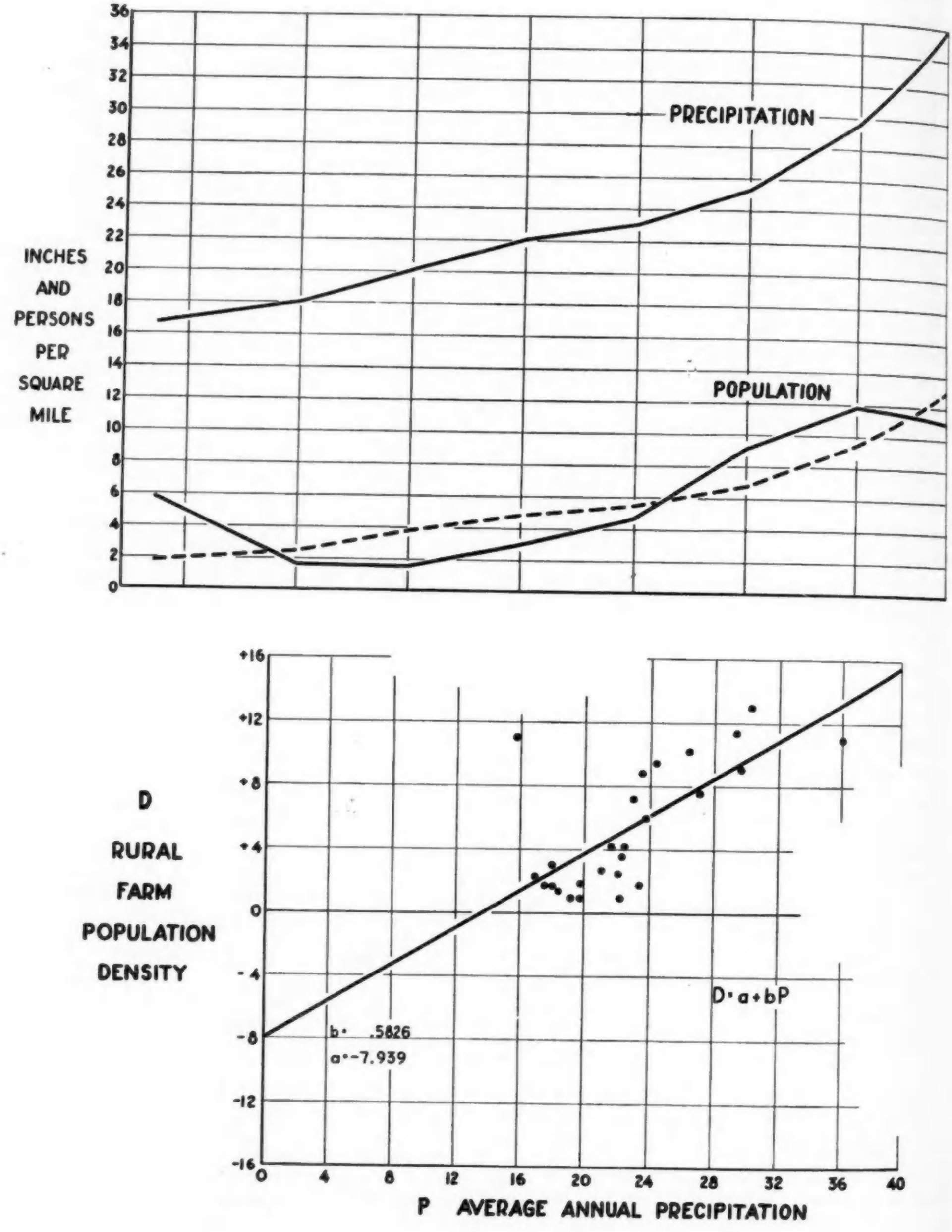



FIG. 3. The scatter diagram at the bottom shows the covariation among the values of average annual precipitation and population density at the grid points shown on the map in Figure 2. Using the constants of the regression of population on rainfall, the east–west "profile" of actual precipitation on the graph at the top (same graph as in Fig. 2) has been made comparable by converting the precipitation values to equivalent population values; the result is symbolized by the dashed line.

20 = 3.7). Actually what has been done is to combine the processes of (1) normalizing the scales and (2) deriving the relation between them. The original (actual) population "profile" and the adjusted (computed) precipitation "profile," stated in equivalent persons per square mile, can now be compared since they are expressed in the same numerical terms.

In similar fashion the isarithms of the original precipitation map can be given new $z$ values by using the regression equation. The isarithms retain their original $x$ and $y$ positions on the map; only their numbering changes. In effect we now have *two* population density maps. One is the actual distribution of population in Nebraska, while the other shows what the population distribution would be if it were entirely dependent upon the distribution of average annual precipitation as defined by the average relation (the linear regression) between the two computed from the values estimated at the grid points.

The next step is to apply the relationship that has been derived. This is done by comparing the two population maps, i.e., the renumbered precipitation map and the original population map. In other words, the "relief" of each of the two statistical surfaces is to be compared. If the correspondence of the population and precipitation distributions were perfect the two surfaces would coincide. The correlation is not perfect, but about 0.8; so in some places the two surfaces will depart from one another. The differences between them are measured on a vertical scale which is, in this instance, expressed as persons per square mile. When the plus or minus departures $(D - D_c)$ of the actual population density surface $(D)$ from the "precipitation–population" surface $(D_c)$ as indicated at the sample points are plotted, isopleths of departures from correspondence can be drawn.

Figure 4 is the map that results from the comparison; the white areas are the regions of greatest correspondence, i.e., the darker the shading the less is the correspondence between the two original maps.[15] The Scotts

[15] Saunders County turns out to be only slightly (2–3 persons per square mile) above what could be expected according to the defined relationship.

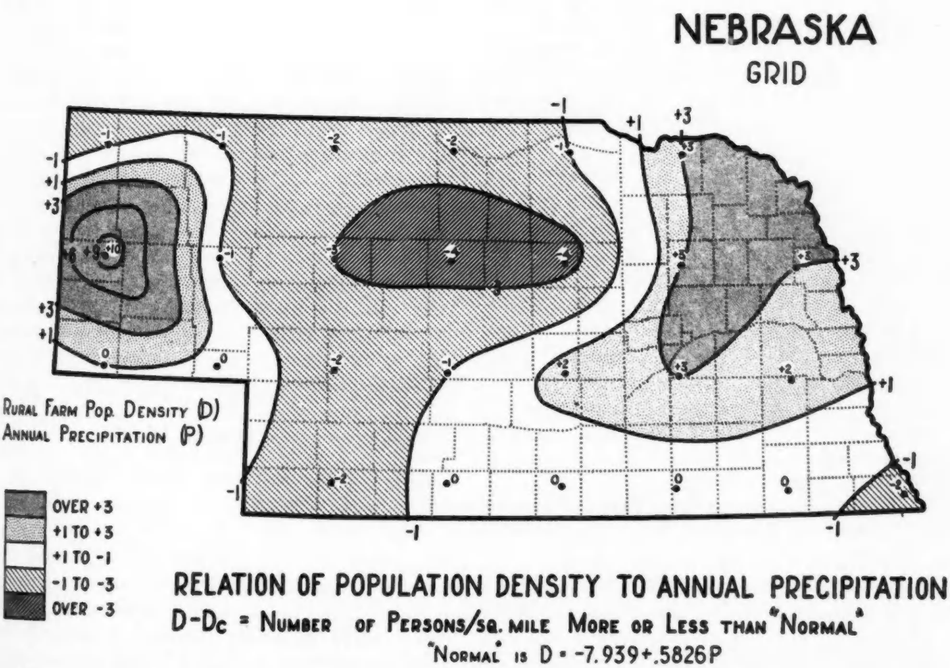



FIG. 4. A map of the degree to which the two maps of Figure 1 (average annual precipitation and rural farm population density) correspond to one another, based only on the values at the sample grid points.

Bluff area in western Nebraska shows a marked plus value, that is, the population surface rises well above the precipitation surface. The central area is a minus region, as is the extreme southeastern corner of the state. In the northeastern section the population surface again rises above the precipitation surface. Although this particular map is relatively crude it is nonetheless interesting. One immediately begins to speculate as to what other factors are associated with the more significant divergences. Such elements as distance from Sioux City and Omaha, soil or drainage characteristics of the Sand Hills, and the extent of irrigation pop up as possible factors, to be used as variables in a further analysis.

### SOURCES OF ERROR IN THE METHOD

The science of geography is plagued by the fact that its investigations are concerned with phenomena containing an enormous number of constantly changing variables, many of which are incapable of very precise observation. Furthermore, many of its basic techniques of cartographic notation require assumptions which turn its maps into what amount to generalized distributions of concepts. The two distributions here employed are representative examples. A map of average annual precipitation is subject to a large number of possible errors, including such things as bias, instrumental errors, variable length of record, etc.[16] The assumptions and kinds of errors inherent in the concept of population density and its computation are even more frightening, as is clear from the literature. All maps are subject to more or less error, especially isarithmic maps. Statistical techniques are also based upon various assumptions, e.g., normality, to name only one, which in given situations may possibly operate further to decrease the precision of results. To catalog all the *possibilities* of error inherent in this method would be out of order; most of them are already available in the cartographic and statistical literature. It is merely necessary to recognize that the usual sources of error are also present in this method.

A further observation is, however, in order here lest one infer more from the results of this method of comparison than is warranted, even assuming no error. The correlation coefficient ($r$) computed for the state as a whole from the paired sample values is about 0.8. From this it may be inferred that over 60 percent of the variations in population density can be accounted for (statistically) by the variations in average annual precipitation. Consequently, there may be a tendency to conclude that the plus or minus regions on the map are the only areas where other factors in addition to precipitation are involved. This is quite incorrect, since in such a complex thing as population density many other factors are no doubt involved in many ways in many places. A regression equation (and a correlation coefficient) are ways of describing the relation between two series of numbers; they *explain* nothing. Secondly, and of vital importance, it should be remembered that the regression of population density on precipitation is a relationship derived for the state *as a whole*, assuming the sample values to be representative.

The above cautionary comments should not be construed to mean that the map of the comparison between the maps of population density and average annual precipitation has no value. On the contrary, the map is a scientific generalization which in quantitative terms describes the manner in which the two original maps correspond to one another using the linear regression between them as a point of departure. The pattern and the direction (positive or negative) of discordance are facts every bit as good as the assumptions and the data on which they are based. It is simply necessary to keep in mind that all scientific generalizations are based upon assumptions and observations, and are subject to more or less error. When derived rigorously in proper scientific fashion the possible sources of error in the procedure can be recognized, and stated, if not well known.

### APPLICATION OF THE METHOD WITHOUT MAPPING

The preceding example of the method started with two general maps and then employed a quick form of sampling to arrive at a small number of paired observations. This was done, not only to illustrate more easily the method through the use of "average east–west profiles" but also to test its applicability to studies wherein a *more* careful analysis was

[16] See, for example, David I. Blumenstock, "The Reliability Factor in the Drawing of Isarithms," *Annals*, Association of American Geographers, Vol. 43 (1953), pp. 289–304.

not desired. The procedures and the mathematics are quite elementary and the entire operation, starting with the two isarithmic maps, required only a few hours. Such a rough and quick approximation or test will be useful in many instances.

A more detailed and thorough comparison of two such distributions introduces a number of problems. Certainly, to prepare detailed maps and to change the nature of the sample so that the results will be subject to less error is not an efficient process when the values from which the maps are to be made are readily available. Stated in statistical terms, it would be foolish to go to the trouble of sampling a universe when it would be easier to work with the universe values themselves. Essentially the same procedure may be followed. One does, however, encounter the problem that the county values relate to areas of different size, and consequently computations to find the regression of population on precipitation must take into account these discrepancies. This problem was solved and the results, of general interest in several connections, were reported earlier in the *Annals*.[17]

The 93 counties of Nebraska were employed as individuals and the average rural farm population density of each was paired with the average annual precipitation of the county.[18] Taking into account the discrepancies in county sizes, the regression of population on precipitation was calculated. The relationship of $D$–$D_c$ was obtained for each county, and the plotted values together with isopleths of departures from correspondence are shown on Figure 5; the scatter diagram is shown at the bottom. A more detailed map results which must be considered better than the one which resulted from the small sample.

### THE ORTHOGONAL POLYNOMIAL METHOD

Another method of arriving at the correlation between two areal distributions is to be found in the use of orthogonal polynomials.

In the preceding discussion the equation of a straight line of best fit (linear regression) was used to describe the statistical relation between average annual precipitation and rural farm population density. This idea may be applied to the example in Figure 2 to introduce the concept of the polynomial approach. The regression of *average precipitation* against *east–west position* in the state of Nebraska could readily be computed from the data used to construct the "average east–west profiles" in the graph at the top of Figure 2. The average values of $P$ (computed from the columns of grid point estimates) at the various longitudes $x$ would be paired, and the linear regression would be calculated by the method given in footnote 14. The regression equation would have the usual form of $P = a + bx$, in which $P$ is the precipitation, $a$ and $b$ are the regression coefficients, and $x$ is position east–west. It is apparent that such a straight line of best fit would not describe very precisely the relationship of the precipitation averages with the longitudes, being especially in error for eastern Nebraska. A better description of the relation between the two sets of numbers could be obtained by employing more coefficients and computing the non-linear regression having the form $P = a + bx + cx^2$. The fit would be still better if the form $P = a + bx + cx^2 + dx^3$ were used, and, if a sufficient number of terms were employed, a perfect description of the relation could be written. To compute a regression equation with many coefficients is a major mathematical chore. To enable one to have the advantage of multiple terms, but to obviate the very great difficulties of solving many simultaneous equations, the orthogonal polynomials of Tschebycheff may be employed. They have the special advantage that coefficients may be fitted one at a time until the reduction in the sums of the squares is no longer of importance, i.e., until the description of the relation is as precise as is desired.

A description of the manner by which orthogonal polynomials are utilized to obtain the desired coefficients is out of place in this paper. Their widespread use in studies involving curvilinear regression is relatively recent, and examples are found in the literature of many fields, such as agriculture, biology, and meteorology. In all instances the studies have been made by researchers with considerable mathematical and statistical backgrounds,

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[17] Arthur H. Robinson, "The Necessity of Weighting Values in Correlation Analysis of Areal Data," *Annals*, Association of American Geographers, Vol. 46 (1956), pp. 233–36.

[18] The county values for average annual precipitation employed were taken from *Climate and Man*, and were for a single station in each county. For the purpose at hand the single station was assumed to be representative of the county.

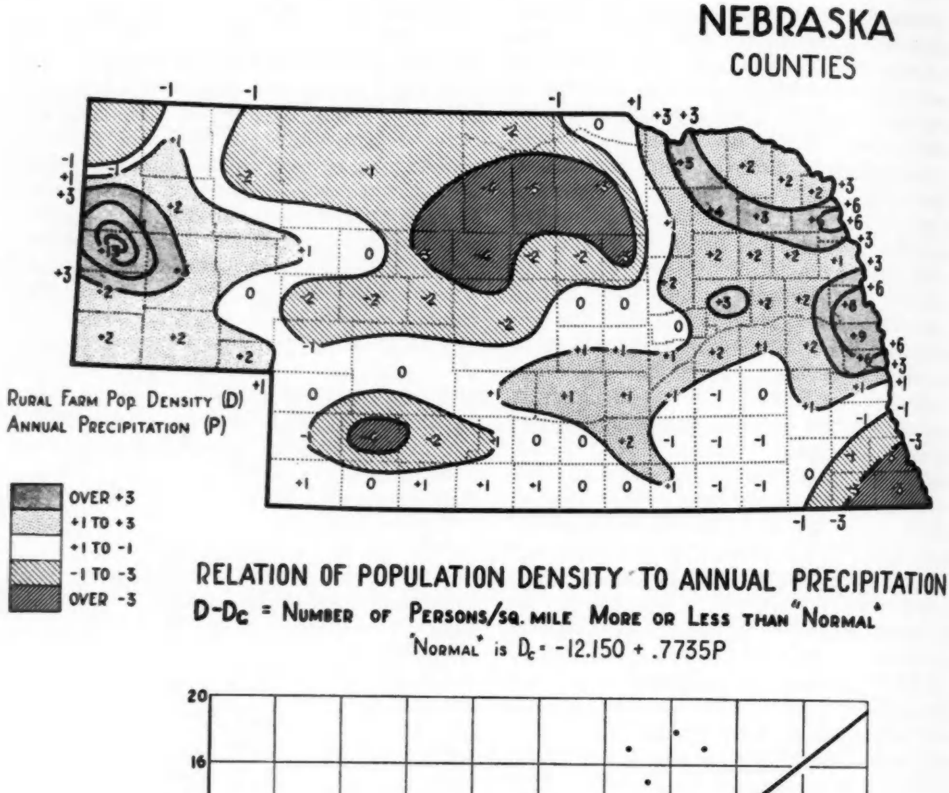


FIG. 5. The scatter diagram at the bottom shows the regression of population on precipitation based on county values. The map at the top results from employing these regression constants. It differs from Figure 4 in two ways: (a) the regression constants are somewhat different, and (b) a correspondence value was determined for each of the 93 counties, whereas only the 26 values at the grid points were employed for Figure 4.

and, as a result, the descriptions of the procedures are difficult for the non-statistician to follow. Nevertheless, since curvilinear regression analysis appears to offer much of value for future research in geography it is appropriate to mention the technique here.[19] The polynomial equations that result describe, as precisely as desired, the nature of the statistical surfaces. They may be normalized in the same general fashion as was done in the case of the preceding linear regression discussed. The curvilinear regression of one surface on another may be employed to derive and map the relation between the two surfaces in the same fashion as previously illustrated. Unfortunately the computation and the manipulation of the normalized orthogonal polynomial coefficients is a rather laborious process; this difficulty can be readily surmounted by the use of high-speed electronic computers, such as the IBM 650 or its equivalent. The machine program for doing this is given in Bryson and Kuhn.[20]

As a sample case, the precipitation and population density values were interpolated from the maps of Figure 1 at intersections of an equally-spaced grid of 37 points east–west and 19 north–south. Data from adjoining states were used to fill in the corners of the grid. After punching the data on IBM cards, two minutes of machine computation produced the result that the two distributions were correlated 0.83, a not-surprising result in light of the previous discussion. Table 1 shows the coefficients of the polynomial terms for each of the maps.[21]

TABLE 1.—ILLUSTRATION OF THE CORRELATION BETWEEN PRECIPITATION ($p$) AND THE POPULATION DENSITY ($d$) OF NEBRASKA BY THE USE OF ORTHOGONAL POLYNOMIAL COEFFICIENTS[1]

| Polynomial term | $p$ coefficient | $d$ coefficient | Partial correlation |
|---|---|---|---|
| *East–west* | | | |
| $a^1$ | —.95 | —.84 | +.7980 |
| $b^1$ | +.06 | +.35 | +.0210 |
| $c^1$ | +.01 | +.16 | +.0016 |
| $d^1$ | —.02 | —.07 | +.0014 |
| $e^1$ | +.01 | —.01 | —.0001 |
| $f^1$ | —.01 | +.05 | —.0005 |
| $g^1$ | .00 | —.03 | —.0000 |
| $h^1$ | —.01 | +.02 | —.0002 |
| *North–south* | | | |
| $a^1$ | +.13 | +.02 | +.0026 |
| $b^1$ | —.04 | —.06 | +.0024 |
| $c^1$ | —.04 | —.04 | +.0016 |
| $d^1$ | +.01 | +.05 | +.0005 |
| Correlation | | | +.8283 |

[1] Computed by James F. Lahey.

One useful property of the normalized equations is that the correlation between the two statistical surfaces described by them may be computed very quickly. If the coefficients of the polynomial equation, after normalizing, are designated by $a^1$, $b^1$, $c^1$, etc. (since they correspond in a way to the $a$ and $b$ of a linear regression equation), and if the subscripts $p$ and $d$ refer to the precipitation and population density maps, respectively, then the correlation ($r$) between the two maps is given by $r = a^1_p a^1_d + b^1_p b^1_d + c^1_p c^1_d \ldots$ etc. There is also the additional advantage that the contribution of each term to the over-all correlation may be seen at a glance, as shown in Table 1. Thus the table shows that (1) most of the correlation is associated with the linear aspect of the distribution (the first term), and (2) that most of the correlation results from the fact that both precipitation and population density change in an east–west direction.

This method, while relatively elegant, would take considerably more time for the computation of a single study of two distributions as here illustrated; but for a much larger area or a more intensive study of an area, where *many* such correlations of distributions are to be made, it provides a powerful research aid.

[19] The work in English stems from the investigations of R. A. Fisher, "The Influence of Rainfall on the Yield of Wheat at Rothamstead," *Phil. Trans. Royal Soc. of London*, Series B, Vol. 213 (1925), pp. 89–142. A relatively clear account of the use and manipulation of orthogonal polynomials in an uncomplicated study is E. E. Housman, *Methods of Computing a Regression of Yield on Weather*, Research Bulletin 302, Iowa Agricultural Experiment Station (Ames: 1942), pp. 863–904. Their use in meteorological research is illustrated by: Don G. Friedman, "Specification of Temperature and Precipitation in Terms of Circulation Patterns," *Journal of Meteorology*, Volume 12 (1955), pp. 428–35; William D. Sellers, ed., "Studies in Synoptic Climatology," *Final Report, ONR Contract N5048–07883*, Department of Meteorology, Massachusetts Institute of Technology (1956); and Reid A. Bryson and Peter M. Kuhn, "Half Hemispheric 500 mb Topography Description by Means of Orthogonal Polynomials, Part I, Computation," *Scientific Report No. 4 under Air Force Contract AF 19 (604)–992*, University of Wisconsin, Department of Meteorology (Madison: 1956).

[20] *Ibid.*

[21] It was clear that in this study so many coefficients would be unnecessary, but they were added for illustrative purposes.

# THE MYTH OF A NATURAL PRAIRIE BELT IN ALABAMA: AN INTERPRETATION OF HISTORICAL RECORDS

ERHARD ROSTLUND
*University of California, Berkeley*

THE crescent-shaped region commonly called the Alabama Black Belt (see Fig. 1) is conspicuous on vegetation maps of North America. It appears in many recent textbooks and atlases and is usually represented as a natural grassland or prairie. Fenneman, for example, says that this region "has always been prairie," and Schmieder calls it a "long and open prairie country which originally extended through the forest."[1] In the *Atlas of American Agriculture*, Shantz and Zon show the crescent as "tallgrass prairie," making use of the same symbol and legend that they employ for the prairies of the Middle West. There can hardly be any doubt about the great and widespread influence of this atlas, for the particular shape and position given the Black Belt in it can be recognized in many other atlases and books published both in this country and abroad and used by several generations of students.[2] It is therefore not strange if many people have been led to believe that an open grassland, 20 to 30 miles wide and some 300 miles in length, once existed in central Alabama and northeastern Mississippi, and doubtless many think that this was a unique vegetation zone in the Southeast, for most of the maps show no other prairie belts in that region. This mistaken belief is so widely held that it may well be called a myth. It behooves geographers and makers of vegetation maps to try to correct the error, for it is mainly they who have perpetuated the misconception, even though they may not have originated it.

It is not entirely clear how the misconception came about, but it probably began in a confusion of terms. A crescent-shaped belt in Alabama and Mississippi is found on the maps of the first state geological surveys, and the term "prairie region" is used in the reports, but with reference to soil, not to vegetation; and the boundaries on these early maps are in reality geological, not vegetational, delimitations (Fig. 2). Indeed, Tuomey's central belt in Alabama is labeled the Cretaceous.[3] Charles Mohr, in his description of the Alabama Black Belt, says, "The term prairie region refers less to the timberless tracts, which originally formed a small fraction of its area, than to the black, calcareous soil. Before settlement by whites this region was largely covered by forests." Very similar comments referring respectively to the prairie regions in northeastern Mississippi and Alabama are made by E. W. Hilgard and Eugene A. Smith.[4] These statements seem to imply that the risk of confusing prairie soil with prairie vegetation already existed a century ago. The confusion has persisted and, if anything, worsened, as is suggested by the fact that the shape and position of the tallgrass region in Alabama and Mississippi, as mapped by Shantz and Zon, is virtually identical with the area of prairie soil in those states, as shown

[1] N. M. Fenneman, *Physiography of the Eastern United States* (New York, 1938), p. 70; Oscar Schmieder, *Länderkunde Nordamerikas* (Leipzig, 1933), p. 202.

[2] H. L. Shantz and Raphael Zon, "Natural Vegetation," *Atlas of American Agriculture* (Washington, D. C., 1924), p. 5. The same prairie belt appears in many other widely used publications, for example: *Bartholomew's Advanced Atlas* (London, 1950), p. 20; *The American Oxford Atlas* (New York, 1951), Plate VIII; *Goode's World Atlas* (New York, 1953), p. 53; *Great Soviet Atlas* (Moscow, 1937), Vol. 1, Plate 43; V. C. Finch, G. T. Trewartha, A. H. Robinson, and E. H. Hammond, *Physical Elements of Geography* (New York, 1957), Plate 5; Arthur N. Strahler, *Physical Geography* (New York, 1951), p. 404; W. A. Albrecht, "Soil Fertility and Biotic Geography," *The Geographical Review*, Vol. XLVII (1957), p. 94. The only recent map, to my knowledge, that shows other prairies in the Southeast, such as the Jackson prairie belt in central Mississippi and other grasslands, is that of A. W. Küchler in *Goode's World Atlas* (1953), p. 53.

[3] Michael Tuomey, *First Biennial Report on the Geology of Alabama* (Tuscaloosa, 1850), Map.

[4] Charles Mohr, "Plant Life of Alabama," *Geological Survey of Alabama*, Monograph No. 5 (Alabama Edition, Montgomery, 1901), pp. 99–100, and Plate I, reprint of *Contributions from the United States National Herbarium*, Vol. VI (Washington, D. C., 1901); Eugene W. Hilgard, *Report on the Geology and Agriculture of the State of Mississippi* (Jackson, 1860), p. 254, and Map; Eugene Allen Smith, "Report on the Cotton Production of the State of Alabama," *Tenth Census of the United States* (Washington, D. C., 1884), Vol. VI, p. 55, and Map opposite p. 19, which is generally similar to the maps of Tuomey and Mohr.

by Marbut.[5] That is, the crescent of alleged grassland in fact represents not a type of vegetation but a group of soils, mostly of the Houston, Oktibbeha, and Susquehanna series. Forests grew on those soils in ancient time, and they do so now.

Roland M. Harper and H. F. Cleland estimate that not more than 10 percent of the Black Belt area was treeless when the American pioneers settled the land in the early part of the nineteenth century.[6] Even smaller proportions of open prairie are indicated by the only two early maps I have found on which actual prairie is distinguished from forest cover, one of northeastern Mississippi in 1857 by L. Harper (Fig. 3), and the other of Sumter County, Alabama, in 1881 by R. D. Webb (Fig. 4). These maps, supplemented by data in the Cotton Report of 1880 by Eugene A. Smith, show that open prairies occupied not more than 6 or 7 percent of the prairie belts in Sumter and Greene counties, Alabama, and about the same proportion of the prairie region in Mississippi as delimited by Hilgard; and the total amount of open prairie in each of the other Black Belt counties of Alabama is given in the Cotton Report as "a few square miles."[7] The myth of a large, continuously open grassland is thus not supported by the best authorities of the last century. The question whether the prairies perhaps were significantly larger in earlier centuries can only

[5] C. F. Marbut, "Soils of the United States," *Atlas of American Agriculture* (Washington, D. C., 1935), Plates 2 and 5.

[6] Roland M. Harper, "Forests of Alabama," *Geological Survey of Alabama*, Monograph 10 (University, Alabama, 1943 [revision of Monograph 8, 1913]), p.160; H. F. Cleland, "The Black Belt of Alabama," *The Geographical Review*, Vol. X (1920), p. 382.

[7] L. Harper, *Preliminary Report on the Geology and Agriculture of the State of Mississippi* (Jackson, 1857), Map, and Plates V and VI; R. D. Webb, "The Relation of Geological Formations and of Soils to Malarial Fevers, as Exemplified in Sumter County, Alabama," *Transactions of the Medical Association of the State of Alabama*, Vol. 34 (1881), Map 1, facing p. 287; Eugene A. Smith, *op. cit.*, pp. 128–29.


Route of De Soto, according to the United States De Soto Expedition Commission (1939) Shaded part, Alabama Black Belt or Prairie Region, after Atlas of American Agriculture (1924)

FIGURE 1

be answered by a search for evidence in the older historical records.

I wish to make it clear at the outset that the purpose of this study is not a botanical reconstruction of the vegetation of the past. The aim is to follow the explorers and early settlers, to envisage the land they saw, and to hear their descriptions and explanations, with the attention not so much upon species of plants as upon the general type of vegetation cover, forest and open country. The Black Belt is not "an island entire of itself," as the myth has made it; the Black Belt is part of the Southeast and must be viewed against the background of the Southeast in order to see if there was anything markedly different or even unique in it, and for that reason it is necessary to include descriptions of areas outside the prairie region in Alabama and Mississippi.

## SIXTEENTH CENTURY

The most important evidence from the sixteenth century is contained in the four narratives of the De Soto expedition, written by Ranjel, Biedma, the Gentleman of Elvas, and Garcilaso de la Vega, El Inca.[8] Not counting all the rivers of which mention is made, there are about 60 references to landscape features in Garcilaso, 40 in Elvas, 35 in Ranjel, and 10 in the relation of Biedma, which is very short. The most probable route of De Soto is undoubtedly the one that has been traced by the United States De Soto Expedition Commission, with John R. Swanton as Chairman (Fig. 1). It is the route accepted here, and all identifications of places are according to the De Soto Commission.[9]

*Florida.* Ranjel makes three brief references to more or less open plains in Florida, in each instance using the term *savana.*[10] Elvas offers only a general comment on this state: "The land is low and very level, the greater part is in pines, and in some places there are high and dense forests [*alto e espeso arvoredo*]."[11] According to Garcilaso, a short distance northeast of Tampa Bay the expedition came to "a great plain [*llano*] fringed by a dense forest [*monte cerrado de matas espesas*]," and for the next 60 or 70 miles along the route (25 leagues) the country consisted "as much of woods as of fields [*tanto de tierra de monte como de campiña*]." In Citrus County they camped on "a good plain," and farther north, between Ocala and Gainesville, the route led through a great forest in which the trees looked "as if they had been planted [*puestos á mano*], being so far apart that horses could safely run between them." In Alachua County they found land that was "clear of underbrush as well as tall trees [*limpia de monte bajo y alto*]." In describing the march through northern Florida from the vicinity of Lake City to the site of Tallahassee, Garcilaso makes several references to dense forest (*monte alto y espeso*), open forest (*monte claro y abierto*), treeless land (*tierra sin monte*), cleared land (*campo limpia de monte*), and plains (*llanos*); and he speaks of cultivated fields (*sementeras*) "extending over the plain as far as the eye could see." North of Tallahassee the scouting parties found many towns in a fertile land clear of forests, but to the south there was "poor country, almost impassable because of undergrowth and swamps [*malezas de montes y ciénagas*]."[12]

*Georgia.* From Ranjel we learn that between the Ogeechee and the Savannah "there was no end of berries in the plains [*savanas*],"

[8] Rodrigo de Ranjel, "Diario" (1545), *in* Gonzalo Fernandez de Oviedo y Valdés, *Historia General y Natural de las Indias* (reprint, Asunción del Paraguay, 1944), Vol. 4, pp. 15–71, translation in Edward Gaylord Bourne, *Narratives of the Career of Hernando de Soto* (New York, 1904), Vol. 2, pp. 41–150; Luis Hernandez de Biedma, "Relación de la jornada que hizo Hernando de Soto" (1544), in Buckingham Smith, editor, *Colección de varios documentos para la historia de la Florida y tierras adyacentes* (London, 1857), Vol. 1, pp. 47–64, translation in Bourne, *op. cit.*, Vol. 2, pp. 1–40; The Gentleman of Elvas, *Relação verdadeira dos trabalhos que o Governador D. Fernando de Souto e certos fidalgos portugueses passaram no descobrimento da Provincia da Florida* (1557), facsimile reproduction, edited by F. Gavazzo Perry Vidal (Lisbon, 1940), translation in Bourne, *op. cit.*, Vol. 1, pp. 1–223; Garcilaso de la Vega, El Inca, "La Florida del Inca, Historia del Adelantado Hernando de Soto" (1605), in *Historia de Méjico, de Los Incas, y de la Florida* (Madrid, 1829), Vols. 6 and 7, translation in J. G. Varner and J. J. Varner, *The Florida of the Inca* (Austin, 1951).

Quoted passages are from the English translations; Spanish and Portuguese terms, occasionally inserted in the text for the sake of accuracy, are from the cited editions in the original language.

[9] John R. Swanton, chairman, *Final Report of the United States De Soto Expedition Commission*, H. Doc. 71, 76th Cong., 1st sess. (Washington, D. C., 1939).

[10] *Op. cit.*, pp. 64, 74.

[11] *Op. cit.*, pp. 59, 220.

[12] *Op. cit.*, pp. 78–260 *passim.*

and that at Cofitachequi, an Indian town on the Savannah River just below the site of Augusta, there were "many fine fields [*buenas savanas*]."[13] The land along the Ocmulgee, says Elvas, had "heavier soil, and was more fertile than Florida, the forest was more open [*arvoredo mais ralo*], and there were very good fields along the streams [*mui boas várzeas de rios*]." Cofitachequi had "good fields and an open forest," and a league and a half off there were "large depopulated towns grown up in grass."[14] Garcilaso describes how they crossed the Flint River in southwestern Georgia and came to "clear land [*tierra limpia*] with many cornfields." Farther north but still west of the Flint, probably in Lee County, "they doubled their marches and could easily do so, for the land was level without woods, mountains, or rivers." Like Elvas, Garcilaso says that the land along the Ocmulgee was "fertile and abundant, with fine forests and clearings [*rasos*]." Marching for six days between the Ocmulgee and Oconee, they found the terrain gentle and the forest easy to pass through, for it was not dense; but on the seventh day they got lost in a wilderness where the ground was craggy and full of brambles (*breñales*), the forest different, higher, denser, and more difficult for travel. Between the Ogeeche and the Savannah they camped in "a very beautiful place," and at Cofitachequi they traveled "a full league through a gardenlike land of fruit-bearing trees, among which a horse could be ridden without any trouble, for they were as far apart as if they had been planted."[15]

*South Carolina, North Carolina, Tennessee.* De Soto marched up the Piedmont between the Savannah and the Saluda rivers to the northwestern corner of South Carolina, and then over the mountains to the town of Chiaha in the Tennessee River valley. Ranjel speaks of three or four plains along the route, using both the term *savana* and the word *llano*.[16] Elvas reports that there were rich lands at Chiaha with many corn fields along the streams (*muitas sementeiras de mais*), and that they rested for thirty days at that place, during which time "the horses fattened on the good pasture."[17] According to Garcilaso, the Piedmont was easy to traverse "either afoot or on horseback, and there was plenty of grass for the livestock." In northwestern South Carolina "they passed many fine fields of tilled lands [*tierras de labor y semeteras*]," and while crossing the mountains during the next five days they saw "a great quantity of oaks and extensive grazing lands [*mucho pasto para ganado*]."[18]

*Alabama.* In Ranjel's narrative of the march through Alabama, mention is made now and then of grapes, plums, oaks, pines, rivers, and of villages in which food was obtained—from which cultivated fields can be inferred—but otherwise nothing is said that can be construed as a clear reference to plains, prairies, savannas, or other types of open country. Elvas and Garcilaso do not have much more to say about the landscape, and like Ranjel they are mostly concerned with the settled and cultivated regions. The province of Coza or the land of the Upper Creeks, according to Swanton, extended from about Etowah and Calhoun counties in the Coosa River valley to the town of Talisi (Talise), which was situated on the left bank of the Alabama at Durand's Bend in Dallas County, about 10 miles east of Selma (Fig. 2, No. 5); and southwest of Talisi was the territory of the Mobile Indians, with their principal settlement at Mabila (Mauvila) somewhere in Clarke County. The land of Coza, Elvas reports, was "thickly settled in numerous towns with fields extending from one to the other, a pleasant place with fertile soil and good meadows along the rivers. Talisi was a large town, and on both sides of the river there were other towns, many corn fields, and an abundance of grain." The land of the Mobile Indians, Elvas continues, was also "fertile and well inhabited, with large towns surrounded by walls, but people were numerous everywhere [*espalhada por todo o campo*], the dwellings standing a cross-bow shot or two apart."[19] Garcilaso says that the province of Coza was "so fertile and thickly populated that on some days the Spaniards passed 10 or 12 towns, not counting those that lay on one side or the other of the road," and Mabila he describes as situated on "a beautiful plain and surrounded by a wall as high as three men."[20] We also learn from

[13] *Op. cit.*, pp. 96, 102.
[14] *Op. cit.*, pp. 66, 220.
[15] *Op. cit.*, pp. 264–314 *passim*.
[16] *Op. cit.*, pp. 103, 104.
[17] *Op. cit.*, p. 74.
[18] *Op. cit.*, pp. 329, 331, 334.
[19] *Op. cit.*, pp. 82, 86, 98.
[20] *Op. cit.*, pp. 342, 353.

Biedma that Mabila was on a plain (*llano*).[21] From Mabila, De Soto went almost due north to the Black Warrior River, passing through regions that Garcilaso calls "peaceful although unpopulated," but no mention is made by any of the chroniclers of plains, savannas, or other types of open land. The Choctaw Indians had settlements on the Black Warrior in later years, but if there was any open country in this part of Alabama in 1540 no record of it is found in the De Soto narratives. After crossing the Black Warrior, the expedition proceeded northwest through Greene and Pickens counties, marching for four days, as Garcilaso states, through level country (*tierra llana*) that had only a few scattered villages.[22] Ranjel and Biedma make no comments on this part of the route, and Elvas only says that the land was unpopulated.

*Mississippi.* The exact route through the Chickasaw country in northeastern Mississippi is not known, and the De Soto Commission indicates several alternates, the most probable of which is shown on the map (Fig. 2). Ranjel has three references to plains (*savanas*) in this region.[23] Elvas says that the land of the "Chicaza" was "thickly inhabited, the people distributed over it as at Mabila, and, since the land was fertile and the greater part of it cultivated, there was plenty of maize." The open nature of the land can be inferred from Elvas' comment on a Chickasaw chief "who was half a league away in an open country [*terra de campina*]."[24] Garcilaso tells us that the principal town was situated on "a flat hill [*loma llana*] between two arroyos, in which there was very little water (even though this was the month of December, 1540) but many groves of walnuts, oaks, and live-oaks," and he further says that after departing from the Chickasaw country they traveled four leagues over "level land, where there were many small settlements."[25] The next open land referred to in the narratives was west of the Mississippi River, but it is unnecessary to follow the expedition that far, and will suffice to say that each of the longer relations contains half a dozen references to open country in Arkansas and Louisiana.

*Summing up.* The most notable impression gained from reading the De Soto chronicles with the eye open for signs of the Black Belt prairie is that there are no such signs. Savannas, plains, and fields were encountered all along the route from Florida to Louisiana, and the Black Belt region does not at all stand out in the record as having had any more open country than other areas. What we do learn from the narratives is that De Soto found much cleared and cultivated land in Alabama and northeastern Mississippi, some of it within the Black Belt but probably as much outside its limits, but there is nothing in the record indicating that an open grassland, 20 to 30 miles broad, was crossed several times. In short, the De Soto narratives, the oldest eyewitness accounts we have, provide no evidence from which the Black Belt prairie, as represented on modern maps, might be reconstructed.

There are not many other sixteenth-century reports to add. The published documents of the Spanish expedition to central Alabama in 1559 under the command of Tristan De Luna give no useful information on the vegetation cover. In Vandera's Memoria of Juan Pardo's exploring journey from the coast of South Carolina in 1566 mention is made three or four times of "very large and good plains [*mui grandes vegas i mui buenas*], clear land [*tierra rasa*], and beautiful plains [*lindas vegas*]," but as far as geographical location is concerned, all we can say is that these lands were probably situated somewhere on the Carolina Piedmont.[26] The records of the attempted French settlements on the coast of Florida and South Carolina in the 1560's do not throw much light on the vegetation in the interior. Laudonnière makes several references to "great plains" and "fair meadows" in Florida, but just how far inland they lay is not clear.[27]

### SEVENTEENTH CENTURY

The seventeenth-century reports are few, and only one pertains to central Alabama. In September, 1686, the expedition led by Marcos Delgado journeyed from Florida to the

[21] *Op. cit.*, p. 18.
[22] *Op. cit.*, pp. 393, 397.
[23] *Op. cit.*, pp. 134, 136.
[24] *Op. cit.*, pp. 100, 102.
[25] *Op. cit.*, pp. 397, 415.

[26] Joan de la Vandera, "Memoria," in Buckingham Smith, *op. cit.*, pp. 16–8.
[27] René Laudonnière, "History of the First Attempt of the French to Colonize the Newly Discovered Country of Florida" (Paris, 1586), in B. F. French, *Historical Collections of Louisiana and Florida* (New York, 1869), pp. 182, 236.

Creek Indian settlements on the Coosa and Tallapoosa rivers (Fig. 2). Delgado's journal records different types of land and vegetation in southeastern Alabama: "a plain of open pine woods," "a thick wood," "3 leagues of difficult wood," "a thick swamp of large trees," and the like. (In Dale County they saw many bears and buffaloes—*cíbolas*. The expedition was approaching the region described a hundred years later by Hawkins as the "beloved bear ground" of the Creek Indians.) The crossing of the Black Belt in Bullock and Montgomery counties is described as follows:

> We traveled 2 leagues through pine woods; then for 3 leagues over rough, hilly ground; and then for 7 leagues north over rough ground without having encountered a drop of water in three days, until we came to a spring. On leaving the spring, we went north 2 leagues and crossed two small thick swamps, and then 1½ leagues over good and level ground to a stream (the Oakfuskee), and later arrived at a river (the Tallapoosa).[28]

A few seventeenth-century reports come from Georgia, Carolina, and Virginia. William Hilton and his boat crew went up the Cape Fear River in 1663, and when they were "near fifty leagues from the river's mouth" they found "good tracts with great burthens of grass." They explored one of these open tracts for several miles, and found that it was "thin of timber, except here and there a great oak, and full of grass," and they "saw no end of the plain."[29] Letters describing Henry Woodward's journeys in 1670 and 1674 from newly-founded Charleston to the site of Augusta, and to other parts of the interior, relate that he discovered "a pleasant and fruitful country, the woods being so clear of coppice and underbrush that a man could ride his horse a hunting." Woodward also observed "many spacious and large savannas."[30] John Lederer, who in 1669 was the first white man to make his way from the Virginia tidewater to the Blue Ridge Mountains, reports having passed several *savanae*, and says that much of the Virginia and North Carolina Piedmont "by the industry of the Indians was very open and clear of wood." Although he found forests on the land, "yet where it was inhabited by Indians, it lay open in spacious plains."[31]

## EIGHTEENTH CENTURY

In the journal of his trip in the winter of 1701 from Charleston to Pamlico Sound by way of the Piedmont, John Lawson makes many comments on the landscape. One day his party traveled "about 20 miles near a savanna, the woods being newly burnt and on fire in many places." This is one of several references to the Indian custom of annually burning the woods. Not far from the site of Charlotte, North Carolina, Lawson observed some abandoned Indian croplands that had become "spread with grass and strawberry vines." After crossing the Yadkin River, probably just east of Salisbury, North Carolina, they journeyed "about 25 miles over pleasant savanna ground, high and dry, having very few trees upon it, and those standing at a great distance apart." The journal contains a dozen descriptions of what Lawson calls "large savannas."[32] Mark Catesby, the naturalist, while exploring the interior of the Carolinas in the 1720's observed many Indian-set fires, as did Lawson, and found numerous "spacious tracts of meadow-land with grass six feet high. The buffaloes ranged in droves, feeding upon the open savannas morning and night, and in the sultry time of day retiring to the thickets of tall cane along the rivers."[33] On a campaign with General Oglethorpe through southern Georgia and northern Florida in 1742, Edward Kimber saw tracts of land so open, "diversified only here and there with rising hummocks of trees," that he began to fancy himself in the well-remembered pasture and meadows of his native Britain.[34]

[28] Marcos Delgado, "The Expedition of Marcos Delgado from Apalache to the Upper Creek Country in 1686," translated by Mark F. Boyd, in *The Florida Historical Quarterly*, Vol. 16 (1937), pp. 2–32.

[29] William Hilton, "A Relation of a Discovery Lately Made on the Coast of Florida" (London, 1664), in Peter Force, *Tracts and Other Papers* (New York, 1947), pp. 10–11.

[30] Henry Woodward, "Letters," in "The Shaftesbury Papers," *Collections of the South Carolina Historical Society*, Vol. 5 (1897), pp. 186, 308–9, 457–8.

[31] *The Discoveries of John Lederer in three several marches from Virginia to the west of Carolina and other parts of the continent*, collected and translated by Sir William Talbot (London, 1672; reprint, Rochester, New York, 1902), pp. 16–24.

[32] *Lawson's History of North Carolina* (London, 1714; reprint, Richmond, Virginia, 1937), pp. 5–52 *passim*, 80, 219.

[33] *The Natural History of Carolina, Florida, and Bahama Islands* (London, 1731–1743), Vol. 2, pp. IV, XXVII.

[34] *A Relation or Journal of A Late Expedition to the Gates of St. Augustine in Florida* (London, 1744; reprint, Boston, 1935), p. 21.

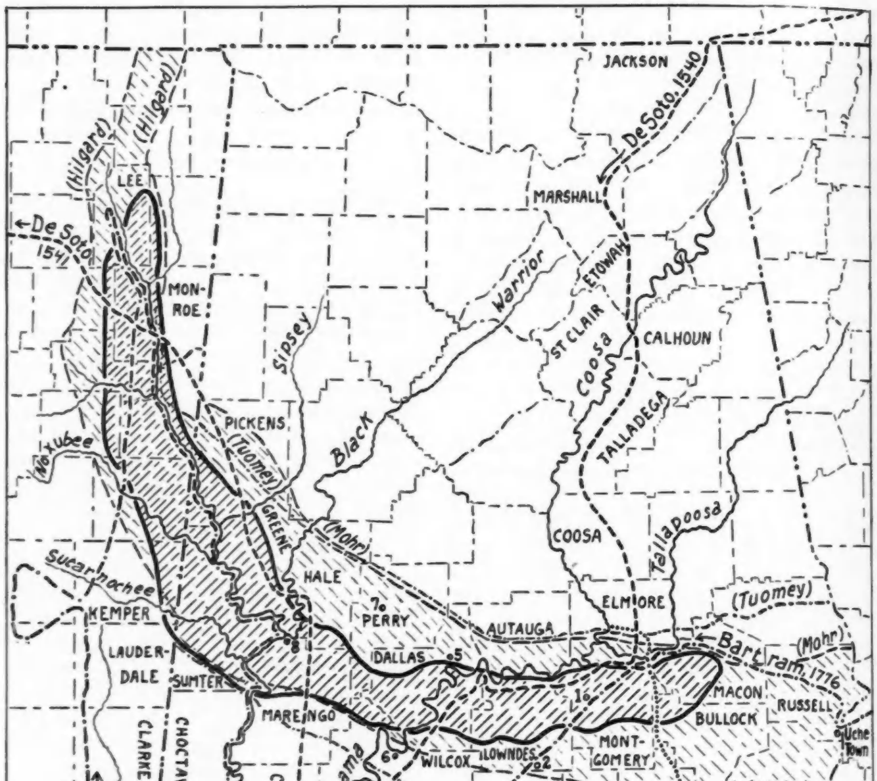
JACKSON
De Soto, 1540
(Hilgard)
LEE
De Soto 1541
MARSHALL
ETOWAH
Warrior
MON-ROE
Sipsey
ST CLAIR
Coosa
CALHOUN
TALLADEGA
PICKENS
(Tuomey)
Noxubee
Black
GREENE
(Mohr)
Tallapoosa
COOSA
Sucarnochee
HALE
ELMORE
(Tuomey)
KEMPER
PERRY
AUTAUGA
LAUDER-DALE
IDALLAS
Bartram, 1776
(Mohr)
SUMTER
MACON
RUSSELL
MARENGO
BULLOCK
Uche Town
CLARKE
CHOCTAW
CLARKE
Alabama
WILCOX
LOWNDES
MONT-GOMERY
(Mohr)
Romans, 1771
WAYNE
Tombigbee
(Limit of Cretaceous)
(Tuomey)
MONROE
PIKE
WASHINGTON
Bartram, 1776
BUTLER
Delgado 1686
Romans, 1772
DALE
CONECUH
GREENE
MOBILE
HOUSTON
JACKSON
GEORGE
Pascagoula
Mobile
BALDWIN
0 25 50 miles
Prairie Region in Alabama and Mississippi:
Heavy shading, according to Atlas of American Agriculture (1924)
Heavy plus light shading, according to Hilgard (1860) and Mohr (1901)
Limits of Cretaceous belt as drawn by Tuomey (1850)

FIGURE 2

James Adair, who traded among the southern Indians in the 1730's and 1740's, writes that in the northern part of what now is the state of Mississippi there were "a number of extensive and fertile savannas, or naturally clear land, interspersed with woods to a great distance, probably 300 miles, the soil of the clear land generally consisting of rich mould to a considerable depth, with a kind of chalk or marl underneath."[35] This remark is of interest for several reasons. Adair is speaking of the Cretaceous belt in northeastern Mississippi and central Alabama, the region of "rotten limestone" in nineteenth-century terminology, and his comment is probably the earliest expression in the literature of the concept of an extensive region characterized by numrous grasslands which are regarded as *naturally clear* lands, a forerunner, that is, of the idea of the crescent-shaped belt of natural prairie represented in modern atlases. But it may be doubted that any historical connection exists between Adair's concept and the modern idea. The "rich mould to a considerable depth" makes it clear that Adair is not referring to the bald prairies with soil so thin that "the plow scrapes the bedrock," as the saying goes, but to the level or gently rolling lands with deep prairie soil. And this was fertile soil, in Adair's opinion. There is no hint that he considered the absence of trees a sign of low soil fertility; and neither is there any such suggestion in the writings of other eighteenth-century travelers in this region.[36]

Bernard Romans, a civil engineer and naturalist who traveled widely in the Gulf region during the 1770's, made a journey in the fall and winter of 1771–72 from Mobile through eastern Mississippi to the Choctaw and Chickasaw nations, and back to Mobile by way of the Tombigbee (Fig 2). The daily entries in the log he kept show that in southeastern Mississippi he traveled through "pine lands," "oak land," "pretty mixed land," "savannas," and many "deserted fields." Circling west from Kemper County, he made a tour of the Choctaw country and found "many old as well as cultivated fields interspersed in the forest," and traveled through "various kinds of woods and savannas." He returned to Kemper County and departed for the Chickasaw country, crossing "many savannas" in northeastern Mississippi, and arrived at the Chickasaw town, which was situated "nearly in the center of a very large and somewhat uneven savanna of a diameter above 3 miles" (presumably Chickasaw Old Fields, Fig. 3). The return trip down the Tombigbee was begun on December 13, 1771, and from that time until he passed the mouth of the Sucarnochee in Sumter County, Alabama, Romans traveled entirely within the Black Belt, but the journal shows that he observed forests as often as open prairie, if not oftener. A few examples from the journal follow. On December 14, presumably in northern Monroe County, Mississippi, he "passed some pine lands." On December 15, a mile or so below the mouth of the Oktibbeha in Lowndes County, "a remarkable bluff came into view, 50 feet high, a mile and a half long, covered with juniper and cedar." Two days later he saw "one of the high savannas with a delightful grassy bluff," and the next day, probably in the southern part of Lowndes County, camp was made on a high bank "timbered chiefly with shagbark hickory, iron wood, and Spanish oak." On January 4, 1772, in Pickens County, Alabama, Romans passed "one of the savannas on the west side," and then voyaged 22 miles through a region where "the canes and the timber were exceeding large." The journal continues in this fashion with comments on both savannas and forests until he was well below Sumter County. Romans also noted open country south of the Black Belt. On January 13 he observed "an old field on the east side," and on the 16th he

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[35] *The History of the American Indians* (London, 1775), p. 461.

[36] It seems to be commonly believed, and in some quarters even regarded as an established fact, that the pioneer settlers from the East were at first skeptical about the fertility of the western grasslands because of the absence of trees. However, Ralph H. Brown says that he found nothing in the old sources indicating doubt in the minds of the first settlers concerning the fertility of the prairies in the Middle West, but also points out that other scholars have reached different conclusions: *Historical Geography of the United States* (New York, 1948), pp. 208, 553. Whatever the pioneers in other regions may have thought of grassland soils, it can be said for the record that the prairie soils in Alabama and Mississippi were regarded as very fertile, not only by James Adair, but by Bernard Romans, William Bartram, Benjamin Hawkins, Caleb Swan, all of them competent eighteenth-century observers, and similar opinions are expressed in a number of reports from the early nineteenth century.

passed "a spacious old field." Both fields were probably in Clarke County.[37]

In 1730, about 40 years before Romans made his journey to the Choctaw towns in east-central Mississippi, Régis du Roullet visited the same region. According to his journal, the village of Castacha (in Neshoba County, just west of Kemper County) was "situated on a large plain [*grande plaine*] with a small hill in the center." The nearby town of Jachou (Yazoo) was also on "a great plain," and the Indians had "their fields on this plain [*ont leur désert dans cette plain*] and their cabins all around it." This plain was not so large as that of Castacha, but "it probably was at least 2 leagues (ca. 5 miles) in circumference." Two villages in Kemper County were on "small plains," and yet another, the position of which is uncertain, was likewise on a "small plain."[38] Captain Lusser, another traveler in the Choctaw country in 1730, describes one village in Neshoba County as situated on "a hill in the form of a prairie, where water was very scarce," and a neighboring settlement he found "very agreeable and surrounded by prairies of rather great extent."[39] In an account by an unknown writer, sometimes called the "Relat de Kened," which according to Swanton probably dates from about 1755, the territory of the Choctaw Indians is depicted as beautiful and as having "very large plains cut up by little streams, the grass in these plains growing to the height of a man." The land of the Chickasaw was even "better provided with these plains than the Choctaw country, the landscape more beautiful, and the soil better."[40]

Another glimpse of the land held by the Chickasaw in northeastern Mississippi is given in De Montigny's narrative of Bienville's campaign against that nation in 1736. The troops ascended the Tombigbee and disembarked a few miles below the mouth of Old Town Creek (Fig. 3).[41] From this point, which is right in the prairie belt, the army "proceeded in two columns through the woods [*au travers des bois*]," and in the evening "halted in a plain surrounded by woods." Next morning the troops crossed a ravine and a wood and entered a beautiful plain. Then the battle began: "Forming a square battalion, our soldiers advanced in good order, like Gideon's of old, gathering bunches of strawberries as they crossed the prairie."[42] In Bienville's own journal we also find several references to prairies in this region.[43]

There is a wealth of other French reports on eighteenth-century Louisiana and neighboring states, many of which are of great historic and ethnographic significance, but they have little or nothing to say about the landscape of interior Alabama and Mississippi. Most of them tell us even less than does Captain Bossu, who in 1759 went upriver from Mobile to Fort Tombigbee (Tombeckbee) in central Sumter County, and all that we can glean from him about the vegetation cover is that his party ascended the Tombigbee "a hundred leagues between forests, camping each night in the woods upon the banks of the river."[44]

The narratives of Swan, Taitt, Hawkins, and Bartram, all of the late eighteenth century, are of particular interest for their descriptions of timberland and open country in the eastern end of the Black Belt. Major Swan of the United States Army, who spent two months in the fall of 1790 among the Creeks and made a brief report of their country, says that the land near the Alabama River in Montgomery and Lowndes counties was "very beautiful with high clear fields along the banks, the soil being of a dark brown color, producing most abundantly, and well tim-

[37] *A Concise Natural History of East and West Florida* (New York, 1775), pp. 62, 305–33 *passim*.

[38] Le Baron Marc de Villiers, "Notes sur les Chactas, d'après les journaux de voyage de Régis du Roullet, 1729–1732," *Journal de la Société des Américanistes de Paris*, N. S., Vol. 15 (1923), pp. 240–41. The Choctaw towns named by du Roullet are identified and located by John R. Swanton, "Source Material for the Social and Ceremonial Life of the Choctaw Indians," *Bureau of American Ethnology*, Bulletin 103 (1931), pp. 61–3, 71.

[39] Captain Lusser, "Journal," in *Mississippi Provincial Archives, French Dominion*, collected and translated by Dunbar Rowland and A. G. Sanders, Vol. 1 (Jackson, 1927), p. 96.

[40] John R. Swanton, "An Early Account of the Choctaw Indians," *Memoirs of the American Anthropological Association*, Vol. 5 (1918), pp. 69–70.

[41] This was Bienville's point of embarkation according to J. F. H. Claiborne, *Mississippi as a Province, Territory, and State* (Jackson, 1880), p. 59.

[42] Dumont de Montigny, *Mémoires historiques sur la Louisiane* (Paris, 1753), Vol. 2, pp. 215–19.

[43] Bienville, "Journal," in Rowland and Sanders, *op. cit.*, pp. 303–5.

[44] Jean Bernard Bossu, *Travels Through That Part of North America Formerly Called Louisiana* (Paris, 1768), translated by J. R. Forster (London, 1771), Vol. 1, pp. 282, 285.

bered with oak, hickory, mulberry, poplar, wild cherry, wild locust, laurel, cypress, bay, gum, cedar, iron, and white cork woods."[45] David Taitt came through Montgomery County in 1772 on a journey from Pensacola and probably passed over the site of Snowdoun or not far from it (Fig. 2, No. 1). In this section, he writes, his party "passed through several little savannas entirely clear of trees or underwood in the middle, and surrounded with rows of trees between each savanna, making a very pleasant prospect for a considerable distance and appearing more like the works of Art than of Nature."[46]

In his short but thorough "Sketch of the Creek Country," Benjamin Hawkins names over fifty Indian towns and in more or less detail describes their lands. Most of them were situated along the Coosa, Tallapoosa, and Chattahoochee rivers outside the Black Belt proper, but some of them were within it. Only a few excerpts from these descriptions can be given here. The part of the Black Belt that lies along the border of Montgomery and Macon counties and extends into Bullock County is drained by the Oakfuskee and its numerous tributaries, and, says Hawkins, "there was good land on all of the eight or nine forks, with growth of oak, hickory, poplar, cherry, persimmons, and cane brakes, a delightful range for stock." He adds the interesting comment that this region was "preserved by the Indians for bear, and was called the beloved bear ground," and explains that each town used to have its own exclusive reserve, but since cattle had increased and bears decreased, the grounds were hunted in common. Along the Tallapoosa from its falls to the confluence with the Coosa there was "good land spreading out on its left," that is, in the northern parts of Macon and Montgomery counties, "and there were several pine creeks on that side, the land bordering them rich, the timber large, and cane abundant." The "good land" continued to the Alabama River and "down it for 30 miles, including the plains," and these plains were "17 miles through, going parallel to the Alabama south 20 degrees west." William Bartram (see below) describes the plains as lying parallel to the river and about 10 miles distant from it. According to Hawkins and Bartram, then, the plains—in later times more commonly known as prairies—began 5 or 10 miles south or southeast of the site of Montgomery and extended in a south-southwesterly direction well into Lowndes County. These plains were the "savannas" of Taitt, the much-quoted "illumined grassy plains" of Bartram, and the section of the Black Belt that has been described more frequently than any other part, for all of the travelers from the Montgomery region destined for Mobile or Pensacola crossed these plains, at first on the old Creek Southwest Trail and in later time on the Federal Road. It may well be that these numerous descriptions, many of them written by passers-by who saw little else of the Black Belt, have helped to create the erroneous impression that prairie vegetation was typical of all of central Alabama. Hawkins describes the plains as follows:

> They are waving, hill and dale, and appear divided into fields. In the fields the grass is short, no brush; the soil in places is a lead color, yellow underneath, and very stiff. [The reader can scarcely avoid the thought that Hawkins may in fact have been describing what once *were* fields, cleared, farmed, worn out, and abandoned.] In the wooded parts the growth is generally post oak, and very large, without any underbrush, beautifully set in clumps. Here the soil is dark clay, covered with long grass and weeds, which indicates a rich soil. . . Four large creeks meander through the level, rich land, well wooded and abounding with cane. There is, notwithstanding these creeks, a scarcity of water in the dry season, and all the creeks were dry in 1799, and not a spring of water was to be found.[47]

The most valuable eighteenth-century report on vegetation in the Southeast is undoubtedly William Bartram's journal, in which there are upwards of fifty separate descriptions of "extensive savannas," "vast meadows,"

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[45] Caleb Swan, "Position and State of Manners and Arts in the Creek, or Muscogee Nation in 1791," in Henry R. Schoolcraft, *Archives of Aboriginal Knowledge* (Philadelphia, 1864), Vol. 5, p. 257.

[46] David Taitt, "Journal," in Newton D. Mereness, ed., *Travels in the American Colonies* (New York, 1916), p. 500.

[47] Benjamin Hawkins, "A Sketch of the Creek Country in the Years 1798 and 1799," *Georgia Historical Society, Collections*, Vol. 3 (1848, reprint, Americus, Georgia, 1938), pp. 22–5, 32. The Indian towns named by Hawkins, Bartram, and other early travelers in the Creek country are identified and located by Albert S. Gatschet, "Towns and Villages of the Creek Confederacy, in the XVIII and XIX Centuries," *Publications of the Alabama Historical Society, Miscellaneous Collections*, Vol. 1 (1901), pp. 386–415, and also by John R. Swanton, "The Indians of the Southeastern United States," *Bureau of American Ethnology*, Bulletin 137 (1946).

"large grassy plains," and the like, by far most of which were situated outside the Black Belt region. Bartram made several journeys in the South, including one to Mobile by way of the Creek country in the eastern end of the Black Belt (Fig. 2). In late June of 1777 or 1776 (perhaps even earlier; the year is uncertain) he joined a company of traders at Augusta, Georgia, followed the old Indian trail near the fall line, crossing the Ocmulgee below the site of Macon, and reached the Alabama border at Yuchi (Uche) Town, which was situated some 20 miles south of Columbus. The first evening after leaving Augusta they came to camp near the Ogeechee on "a pleasant grassy open plain." At the Oconee River they stopped for the night in "a delightful grove of oak, ash, mulberry, hickory, black walnut, elm, sassafras, locust, etc. This grove extended into an extensive, green, open, level plain, consisting of old Indian fields and plantations, stretching to a very great distance." After leaving the Oconee, they traveled "over a pleasant territory affording sublime forests contrasted by expansive illumined green fields, native meadows and cane brakes." At the Ocmulgee, Bartram observed the "famous old fields," and west of the Flint River they halted for the night "on the acclivity of a swelling ridge with open airy groves of superb pines, glittering rills playing beneath, and pellucid brooks meandering through an expansive savanna." Then they passed through "almost endless grassy fields, detached groves, and green lawns extending for the distance of nine or ten miles." In his journal of the trip from Augusta to Uche Town, Bartram describes at least ten large open plains or savannas.

From Uche Town, Bartram proceeded north on the Alabama side of the Chattahoochee, "riding over a level plain consisting of ancient Indian plantations," and arrived at the Indian settlement of Apalachicola (Apalachucla) a few miles up the river. He then traveled west through Russell and Macon counties, probably passing near the site of Tuskegee, and came to the bend of the Tallapoosa after a journey of three days "over a vast level plain country of expansive savannas, groves, cane swamps, and open pine forests." Descending along the left bank of the Tallapoosa "continuously in sight of Indian plantations," Bartram reached Old Coolome, where he found "very extensive old fields, the abandoned plantations and commons of the old town, the settlement having been removed to the opposite (northern) shore." Coolome (Kulumi or Kolomi, Coo-loo-me in Hawkins), according to Gatschet, was situated on the Tallapoosa about 13 miles above its junction with the Coosa, that is, in the northeastern corner of Montgomery County. It was from Coolome that Bartram took his departure for Mobile.

The exact route to Mobile cannot be identified from Bartram's writing, but, as Roland M. Harper suggests, it probably ran in a general southwesterly direction, passing near the sites of Snowdoun, Fort Deposit, Burnt Corn, and Tensaw (Taensa; Fig. 2, Nos. 1, 2, 3, and 4).[48] These sites just about mark the route of the old Federal Road, which was built in the early nineteenth century along the ancient Creek Southwest Trail, according to Peter Hamilton.[49] And this trail may well have been the "trading path for West Florida" that Bartram says he set out on.

The route on the first day after leaving Coolome presents no problem. "Early in the morning we set off for Mobile. Our progress for about 18 miles was through a magnificent forest, frequently having in view the distant towns over plains or old fields, and at evening we came to camp in a grove of venerable oaks on the verge of the great plains." The magnificent forest was in the northeastern part of Montgomery County, and, having come 18 miles on a course that could only have been in the southwesterly quadrant, the position of their camp—at the verge of the plains—must have been 5 or 10 miles south of Montgomery, very likely near the site of Snowdoun (Fig. 2, No. 1).

The next day's entry in the journal contains Bartram's description of the plains.

> We continued over these expansive illumined grassy plains, or native fields, about 20 miles in length, and in width 8 or 9, lying parallel to the river, which was about 10 miles distant. They are invested by high forests, extensive points or promontories, which project into the plains on each side, dividing them into many vast fields opening on either hand as we passed along. The surface of the plains or fields is clad with tall grass, intermingled with a variety of herbiage. The upper structure or vegetable mould of these plains is perfectly black, soapy, and rich, especially after

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[48] *Op. cit.*, p. 11.

[49] Peter J. Hamilton, "Indian Trails and Early Roads," *Publications of the Alabama Historical Society, Miscellaneous Collections*, Vol. 1 (1901), pp. 423, 426.

rains, and renders the road very slippery; it lies on a bed of white limestone rocks, which in places resemble chalk, and in other places there are strata of various kinds of sea shells, these dissolving near the surface and mixing with the superficial mould renders it extremely productive.

The journal continues, "Immediately after leaving the plains we entered the grand high forest. There were stately trees of Robinia pseudoacacia, Tilia, Morus, Ulmus, Juglans exaltata, Juglans nigra, Pyrus coronaria, Cornus florida, Cercis etc." The first impression is that Bartram is here speaking of the timberland south of the Black Belt, and perhaps he is, but there is a possibility that this forest was within the prairie region, for in the same paragraph Bartram says," "Our road now for several miles led us near the Alabama, within two or three miles of its banks." The journal is not clear at this point; but Bartram certainly could not have come within a couple of miles of the Alabama had he continued on a southwesterly course after leaving the plains. He may have shaped a more westerly course at some time during this day, which apparently was the second day out from Coolome, perhaps along the old Alabama–Choctaw Trail,[50] and in that event he *would* have approached the river, possibly near Benton in Lowndes County, where the Alabama meanders southward for 6 or 7 miles. The suggestion that this was the route seems to be supported by Bartram's next entry in the journal, in which he says that they now left the river at a good distance, bore away southerly, and entered "a vast open forest which continued above 70 miles."

While the position of the "grand high forest" may be uncertain, it seems clear that when Bartram entered the vast and open seventy-mile forest he was south of the Black Belt. Two points stand out in his description of this forest: it was no monotonous pinery, and there was plenty of open country in it. "This forest," he writes, "consists chiefly of oak, hickory, ash, sour gum, sweet gum, beech, mulberry, scarlet maple, black walnut, dogwood, Cornus florida, Aesculus pavia, Prunus Indica, Ptelea, and an abundance of chestnut on the hills, with Pinus taeda and Pinus lutea." (Botanists will recognize that some of the specific names used by Bartram have been changed since his time.) The open character of the forest is clearly indicated: "During our progress over this vast forest we crossed extensive open plains, the soil gravelly, producing few trees and shrubs or undergrowth." And again Bartram says, "We traveled about 20 miles through a landscape of expansive plains of cane meadows, and detached groves." In Monroe County, having crossed one of the branches of the Escambia River, Bartram observed that the country was gently but perceptibly dropping toward the Gulf, and here he noted a landscape that was "very different from what had been observed since leaving the Creek nation, and not unlike the low countries of Carolina, being in fact one vast flat grassy savanna and cane meadow, intersected and variously scrolled over with narrow forests and groves." Shortly thereafter Bartram reached Taensa, "embarked in a boat and proceeded for Mobile."[51]

[50] For the route of the old Alabama–Choctaw Trail, see William E. Myer, "Indian Trails of the Southeast," *Bureau of American Ethnology*, Annual Report, Vol. 42 (1924–25), p. 748.

[51] William Bartram, *Travels through North and South Carolina, Georgia, East and West Florida, the Cherokee country, the extensive territories of the Muscogulges, or Creek Confederacy, and the country of the Chactaws* (London, 1794), pp. 374–401 *passim*.

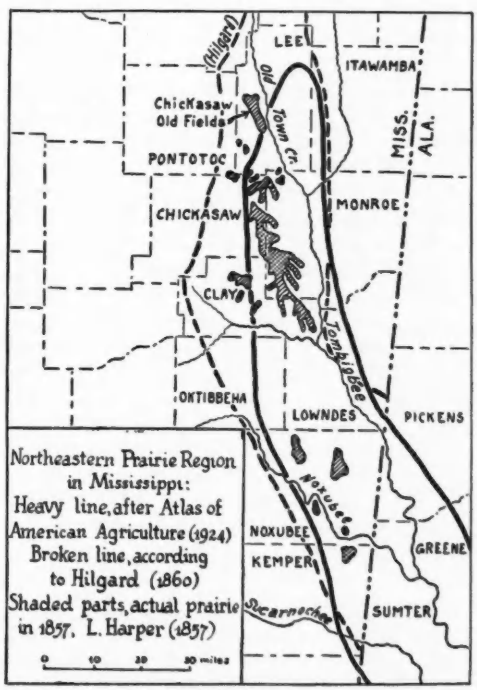


FIGURE 3

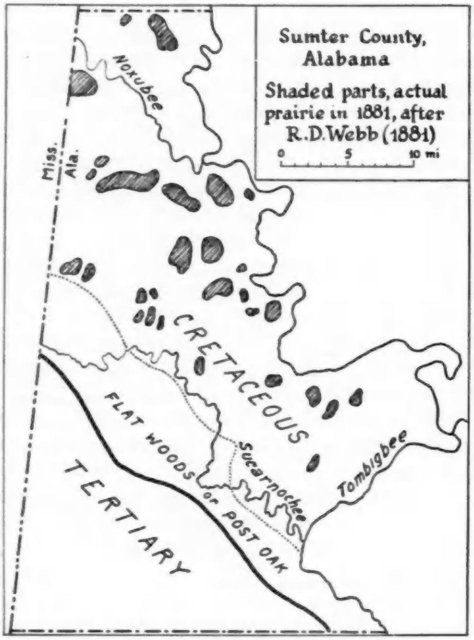


FIGURE 4

### NINETEENTH CENTURY

Nineteenth-century reports on the Southeast are very numerous; so only those that describe the Black Belt region are considered. These descriptions bring out especially two things: the appearance of the prairie sections and the prevalence of timber in the Black Belt.

The journal of Major Howell Tatum's survey of the Alabama River in 1814 is mostly a record of courses and distances but also includes brief remarks on the land. Tatum, like Romans in his descent of the Tombigbee, found timbered bluffs and banks alternating with open country, and generally his comments on the former outnumber his remarks on the latter, whatever that may mean. His notes of August 14 and 15, when he crossed the Black Belt from Durand's Bend east of Selma (Fig. 2, No. 5) to Canton Bend in Wilcox County (Fig. 2, No. 6), contain about a dozen references to "pine lands," "timbered bluffs," "pine, oak, and hickory growth," or other forest terms.[52]

A description by W. Roberts, another surveyor, of the part of the Black Belt that lies east and south of the Alabama River in Dallas, Lowndes, and Montgomery counties was published in 1818 and reads as follows:

> Next to the river swamp, and elevated above it by a bluff, we enter upon an extensive body of level, rich land, of fine black, or chocolate-colored soil. The principal growth is hickory, black oak, post oak, dogwood, and poplar are also common, but pine is rather scarce... After this comes in the prairies. These are wide-spreading plains, of a level or gently waving land, without timber, clothed in grass, herbage, and flowers, insulated by narrow skirts of rich interval woodland. The soil is generally of a fine black rich cast and has the appearance of great fertility. . . . The only objection to this part of the country seems to be the want of water.[53]

The prairies near Cahaba, Dallas County, in 1821 are described in these words by J. W. Heustis, an early settler:

> Before you is a wide and extended meadow; to the right and left intervening strips of oak and pines; proceeding onwards, the prospect seems terminated by the surrounding woods; anon, you catch a glimpse of the opening vista; and again the prospect expands into the widespreading horizon of an extensive prairie. These praires are generally rolling; the quality of the soil is admitted to be the best the country affords; and the only objection is the scarcity of good water.[54]

Another description of the same region is given by Philip Henry Gosse, who taught school in Dallas County during the 1830's:

> There are in this neighborhood many prairies, not the boundless prairies of the West, but little ones, varying in extent from an acre to a square mile. They are generally so well defined, that the woods environ them on all sides like an abrupt wall, and one can hardly be persuaded that these prairies are not clearings made with the axe of the settler... The residents on the prairies suffer greatly in the dry season from the scarcity of water.[55]

James Stuart, speaking in 1830 of the plains southwest of Montgomery, says, "In many of the prairies are what are called islands of wooded land. They generally have the appearance of such beauty, and are so well placed, that a stranger is with difficulty con-

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[52] Major Howell Tatum, "Topographical Notes and Observations on the Alabama River, August 1814," in Peter J. Hamilton and Thomas M. Owen, eds., *Transactions of the Alabama Historical Society*, Vol. 2 (1898), pp. 135–50.

[53] Quoted in William Darby, *The Emigrant's Guide to the Western and Southwestern States and Territories* (New York, 1818), pp. 132–3.

[54] "Letter," in Thomas Perkins Abernethy, *The Formative Period in Alabama, 1815–1828* (Montgomery, 1922), p. 22.

[55] *Letters from Alabama* (London, 1859), pp. 75, 80–1.

vinced that they are not planted."[56] Commenting on the prairie region in northeastern Mississippi in 1827, Thomas McKenney remarks, "There are prairies in that district, large and level. Pretty groves occasionally rise out of them, whilst a fringe of woodland belts them around. But there is no water."[57]

Many of the early accounts clearly reveal the prevalence of timbered land in the Black Belt. In 1817, according to S. A. Townes, the site of Marion in Perry County (Fig. 2, No. 7) "was covered with a dense forest."[58] Another Marion settler reports, "I came to Perry County in 1832. Passing through the Creek country, we camped at Mt. Meigs near Montgomery, where farmers were picking cotton and clearing land—the axes were cutting until midnight, and an hour before day next morning. [This was Bartram's "magnificent forest" in northeastern Montgomery County that was being cleared.] We camped near Marion Saturday night, and here Negroes were cutting timber all night until sunrise Sunday."[59] The region granted by Congress in 1817 to a group of French émigrés, who founded Demopolis in Marengo County (Fig. 2, No. 8), is described by Pickett as "an immense forest, interspersed with prairies."[60] Levasseur, accompanying Lafayette on a steamer down river from Montgomery in 1825, was impressed by the "always wooded banks of the Alabama."[61] Stephen Elliott does not give a detailed description of the Black Belt in his Southern botany of 1824, but says that the district with the finest forests in the United States is "the country which encloses the Alabama and its tributaries."[62] In 1836 Tuskegee, Macon County, appeared to an Army surgeon as "a spot in the primeval forest laid out in town lots on which a few buildings had arisen among stumps and burnt trees."[63] A traveler approaching Montgomery by river in 1834 was impressed by "the green forest crowning the bluff on which the city was built,"[64] and twenty years later Frederick Law Olmsted observed that "from the state house of the fine and promising town of Montgomery the eye falls in every direction upon a dense forest, boundless as the sea."[65] The following description of the Alabama prairies dates from 1830:

> There are open prairies of every size from 100 to 1200 acres, mixed and interspersed in every form and mode with timbered lands of all kinds; some producing only black-jack and post-oak; others again covered with most majestic oak, poplar, elm, hickory, walnut, pecan, hackberry, grapevine, and cane.[66]

A trace of former forests is seen in M. C. Boyd's note of the "ever-present stumps" encountered by the plowman in Greene County during the 1850's.[67] Much of the timber was cleared away during the nineteenth century, when the prairie belt became one of the leading cotton producers of the South, but despite this clearance it was estimated in 1878 that about 45 percent of the area of the Black Belt counties in Alabama remained in forest.[68]

The crescent-shaped prairie belt shown in many modern atlases cannot be recognized in, or reconstructed from, the great nineteenth-century works on botany, or from the magnificent silvas of North America by André Michaux, Thomas Nuttall, or Charles Sprague Sargent; nor can it be found on the maps accompanying Sargent's comprehensive forest report for the *Tenth Census of the United States* in 1880. Map No. 1 of that report shows the "Forest, Prairie, and Treeless Regions of North America," Map No. 16 the "Relative Density of Existing Forests," and on neither

[56] *Three Years in North America* (Edinburgh, 1833), Vol. 2, p. 175.

[57] *Memoirs, Official and Personal, with Sketches of Travels among the Northern and Southern Indians* (New York, 1846), p. 163.

[58] "The History of Marion, Sketches of Life in Perry County" (1844), *The Alabama Historical Quarterly*, Vol. 14 (1952), p. 179.

[59] W. T. Jordan, "Early Ante-Bellum Marion, Alabama," *ibid.*, Vol. 5 (1943), p. 27.

[60] Albert James Pickett, *History of Alabama* (1851; reprint, Sheffield, Alabama, 1896), p. 625.

[61] August Levasseur, *Lafayette en Amérique* (Paris, 1829), Vol. 2, p. 187.

[62] *A Sketch of the Botany of South Carolina and Georgia* (Charleston, 1816–24), Vol. 2, p. 608.

[63] Jacob Rhett Motte, *Journey Into Wilderness, An Army Surgeon's Account of Life in Camp and Fields during the Creek and Seminole Wars of 1836–1838*, James F. Sunderman, ed. (Gainesville, Florida, 1953), p. 22.

[64] Charles U. Shepard, "Geological Observations upon Alabama, Georgia, and Florida," *The American Journal of Science and Arts*, Vol. 25 (1834), p. 163.

[65] *A Journey in the Seaboard Slave States* (New York, 1861), p. 574.

[66] W. W. McGuire, "On the Prairies of Alabama," *The American Journal of Science and Arts*, Vol. 26 (1834), p. 96.

[67] *Alabama in the Fifties* (New York, 1931), p. 37.

[68] Saffold Bernay, *Handbook of Alabama* (Mobile, 1878), p. 221. The forest data in this handbook were contributed by Charles Mohr.

map is there any sign of open, treeless land in the region of the Black Belt.[69] The absence of the Alabama prairies from these and other maps of the nineteenth century does not mean that there were no prairies, nor that the makers of the maps were ignorant of them, but it must mean that in their opinion the vegetation cover of the Black Belt region was not sufficiently different from that of surrounding areas to warrant a different map symbol.

### TWENTIETH CENTURY

The two most recent developments relevant to this study are: the first appearance on a vegetation map of the crescent-shaped prairie region, and the marked actual increase during the last few decades of the forested area in the Black Belt counties.

So far as I know, the Black Belt region in its present familiar shape and position first appeared on a forest map of the United States that was published in 1923 as part of a work which was described by Zon and Sparhawk, the authors, as a semi-official publication of the Forest Service.[70] The maps in this work are said by the authors to be original and never published before, and no further documentation or source of the maps is given. On this forest map, however, the crescent-shaped region is not labeled as prairie; it is merely a blank space on the area represented as forest. But on the map of Shantz and Zon, which came out the following year, the blank space has been filled with the symbol for tallgrass prairie, and it is clearly this map that has become the prototype for many others in recent years.[71] The present shape and position of the crescent thus appears to have originated with Zon and Sparhawk, and it became a natural grassland with Shantz and Zon. Distinction must be made between the map of Shantz and Zon and their description of prairie vegetation, for it is the map that has been widely copied, not the description; indeed, a description of the prairies in Alabama and Mississippi could not have been copied from them, for they give none. The excellent discussion and all of the photographs in Shantz's section on grassland vegetation pertain to the Midwestern and far Western prairie and deserts, and it is not clear just how the Alabama Black Belt came to be mapped as a natural prairie. It may well be that there was no intention of representing it as a region that *always* had been a grassland. Shantz writes in a personal communication, "I do not regard our prairie as a thoroughly natural climax since it is continually thrown back by fire."[72]

Much of the land that was cleared for cotton during the nineteenth century has been abandoned as cropland in the twentieth, and is being reforested by a natural encroachment of trees.[73] The forest surveys have revealed that approximately 47 percent of the area of the 12 Alabama counties through which the main part of the prairie belt runs (Autauga, Bullock, Dallas, Greene, Hale, Lowndes, Macon, Marengo, Montgomery, Perry, Pickens, and Sumter) was forested in 1935, whereas about 56 percent of the area of the same counties was forested in 1952, showing an increase of 19 percent in 17 years. The corresponding increase in 8 Mississippi counties (Chickasaw, Clay, Kemper, Lee, Lowndes, Monroe, Noxubee, and Oktibbeha) was a little over 12 percent in the 14 years from 1933

[69] Charles Sprague Sargent, "Report on the Forests of North America," *Tenth Census of the United States* (Washington, D. C., 1884), Vol. 9, Map Nos. 1 and 16 in portfolio accompanying the volume.

[70] Raphael Zon and William N. Sparhawk, *Forest Resources of the World* (New York, 1923), Vol 2, Plate XI facing p. 522. There are several early twentieth-century vegetation maps on which the Alabama prairie belt does not appear, for example: John W. Harshberger, "Phytogeographic Survey of North America," in A. Engler and O. Drude, *Die Vegetation der Erde* (Leipzig and New York, 1811), Vol. 13; Forrest Shreve, "A map of the Vegetation of the United States," *The Geographical Review*, Vol. III (1917), pp. 119–25; V. E. Shelford, *Naturalist's Guide to the Americas* (Baltimore, 1926), figs. 3, 4, and 5. A large reproduction from the original full-size blueprints of Shelford's maps is found in A. L. Kroeber, *Cultural and Natural Areas of Native North America* (Berkeley, 1939), Map 3. Other maps appear in Cleland and Roland M. Harper, *op. cit.*, but their regions, labeled Black Belt, Blue Marl, Eutaw Belt, and so on, are not truly vegetation zones so much as they are geological or soil differentiations, resembling the maps of Tuomey, Hilgard, Mohr, and E. A. Smith.

[71] Shantz and Zon, *loc. cit.*

[72] Letter from H. L. Shantz, April 1956.

[73] "That this second growth was not purposely grown by man, but happened to develop through natural means, is indeed worthy of note." A. R. Spillers, *Forest Resources of Southeast Alabama*, Forest Survey Release No. 47 (December 1939), p. 8.

to 1947.[74] P. R. Wheeler, Chief of Forest Economics at the Southern Forest Experiment Station, informs me that it has not been determined exactly how much of the increase was contributed by the part occupied by the Black Belt itself, but observations suggest that it was not an unusually large share. I take this to mean that neither was the share unusually small but about average. It is not known, of course, how far this encroachment by the forest would go if it were allowed to take its natural course, but, in reply to my question, Wheeler expressed the belief that if there were no interference by man the Black Belt would probably in time become a predominantly forested region.[75] I suspect that many foresters share that opinion. It may be noted that the latest maps of the Forest Service do not show the crescent-shaped region, whether as prairie or blank space. Central Alabama and northeastern Mississippi are now represented as forest land, as they were on Sargent's maps in 1880. In the combined light of the historical record and these latest developments, it is becoming increasingly hard to believe that the Black Belt was ever a *natural* grassland.

## MEANING OF THE HISTORICAL RECORD

The substance of the old reports is that the early observers (1) found two kinds of forest, (2) discovered several types of open, treeless land, and (3) encountered these open lands not only in the Alabama Black Belt but throughout the Southeast.

1. One kind of forest was "high and dense," the *monte alto y espeso* of the Spanish explorers, obviously a forest dominated by stands of mature timber and difficult to pass through because of heavy undergrowth. These dense woods were undoubtedly virgin forests undisturbed by man, or at least relatively unaffected by human action for a long time prior to observation. How widespread they were in aboriginal time is hard to say, but it can be said that there are not very many references in the early historic record to forests of this type. It is almost certain that the "forest primeval" was not nearly so universal in precolonial time as seems to have been commonly believed a generation or two ago.[76]

The second type of forest was a sunlit wood, *claro y abierto*, the "open airy grove" of Bartram, with trees so far apart and so clear of underbrush that horses could freely gallop from glade to glade. Captain John Smith tells us that in Virginia "all the woods for many an hundred miles grew slight, like unto a high grove, not thicke together, and much good ground betweene them without any shrubs."[77] On the Cumberland Plateau in Tennessee, according to Featherstonhaugh, "the openness of the woods gave a parklike appearance to the country, and enabled you to see through the forest for a great distance."[78] Adam Hodgson rode from Natchez to the Choctaw country in central Mississippi and found that the forest was "delightful, open and interspersed with occasional small prairies, and had the appearance of an English park."[79] Comments in this vein are found in so many of the old narratives, and in reports from so many different parts of the Southeast, that one can hardly avoid drawing the conclusion that open woodland with little or no underbrush must have been the most common type of forest. Some of the early observers speculated upon the reason for the open character of the forest, and suggested that the cause was the Indian

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[74] The comparisons are based on information in: A. Duerr, *Basic Data on Forest Area and Timber Volumes from the Southern Forest Survey, 1932–1936*, Forest Survey Release No. 54 (February, 1946), pp. 7–8, 21–2; L. M. James, *Mississippi's Forest Resources and Industries*, Forest Resource Report No. 4 (1951), p. 64; and P. R. Wheeler, *Forest Statistics for Alabama*, Forest Survey Release No. 73 (December, 1953), p. 17.

[75] Letter from P. R. Wheeler, July 1954. I am also indebted to Mr. Wheeler for calling my attention to the studies of George D. Scarseth, who says that the Oktibbeha clay was heavily timbered in the virgin state. *Morphological, Greenhouse, and Chemical Studies of the Black Belt Soils of Alabama*, Agricultural Experiment Station of the Alabama Polytechnic Institute, Bulletin 237 (Auburn, 1932) p. 11.

[76] The older opinion is exemplified in this statement, "From Maine to Alabama the woods were unbroken and impassable. The great Appalachian forest was in primitive days an exceedingly dense tangle." Nathaniel S. Shaler, *Nature and Man in America* (New York, 1891), p. 195. A very different idea is expressed in Professor Carl Sauer's comment, "Our eastern woodlands, at the time of white settlement, seem largely to have been in process of change to park lands," in *Man's Role in Changing the Face of the Earth* (Chicago, 1956), p. 55.

[77] *Travels and Works of Captain John Smith*, Edward Arber, ed. (Edinburgh, 1910), p. 950.

[78] G. W. Featherstonhaugh, *Excursion through the Slave States* (London, 1844), Vol. 1, p. 185.

[79] *Remarks During a Journey Through North America in 1819, 1820, and 1821* (New York, 1823), p. 273.

practice of burning the woods at frequent intervals. That opinion is shared by some of the forest authorities of today.[80] Indian burning has sometimes been both misunderstood and misrepresented; it was not wantonly destructive but was rather, as Gordon M. Day puts it, a method of maintaining a balance in the forest favorable to their economy.[81] The woods were burned for several reasons, but one of the most common was the belief that occasional light fires helped to increase the food supply for game, and improved conditions for hunting by keeping down the underbrush. That is, burning was primitive management of a food resource. The hunting territory of the Creeks, their "beloved bear ground" in Bullock County, Alabama, was in fact a sort of managed game preserve, and there must have been hundreds of others in the Southeast. In short, the open, parklike appearance of the woodlands, undoubtedly the most common type of forest in the ancient Southeast, was mostly the work of man.

2. There were several types of open, treeless land: cultivated fields, which generally had been cleared of forest; abandoned croplands and uncultivated lands variously described as prairies, savannas, meadows, plains, fields, glades, and the like.

Most of the prairies, to use a single term for the last group, were small, only a few acres to a square mile in extent, but some of them were much larger. Bartram says that the Alachua savanna in northern Florida was "a level green plain, above 15 miles over, 50 miles in circumference, with scarcely a tree to be seen."[82] The plain southwest of Montgomery extended 18 miles, according to Hawkins; Lawson rode 25 miles over a stretch of open country in North Carolina; and the largest savanna known to Bernard Romans (probably the prairie in western Monroe County, Mississippi, Fig. 3) "was nearly 40 miles over from north to south."[83] McKenney crossed part of a prairie in northeastern Mississippi that was said by his guide to be over 100 miles in length, but this hearsay can hardly be taken as valid evidence of a single, continuous prairie that long. However, open sections of such dimensions may have existed here and there, as is suggested by reports from other regions. William Henry Foote refers to the existence in the 1750's of "vast prairies" and "extensive tracts covered only with grass" on the North Carolina and Virginia Piedmont and along the Holston and Clinch rivers in the folded Appalachians.[84] In these descriptions Foote gives no dimensions expressed in miles, but Hu Maxwell, basing his statement on other data of Foote (not available to me), says that the prairies in the Shenandoah Valley, with only scattered trees along the water courses, extended over a distance of 150 miles and covered an area of 1,000 square miles in one body.[85]

The old narratives do not give us much exact information on the dimensions of the cultivated fields, which in some regions seem to have been very large, "extending over the plains as far as the eye could see," as De Soto's men observed in Florida. Bartram describes the abandoned croplands along the Ocmulgee below the site of Macon as 20 miles in length, and ancient Apalachucla in Russell County, Alabama, he judged to have been "a very populous settlement from its expansive old fields stretching beyond the scope of sight."[86] The Virginia Indians, according to Maxwell, by means of their clearings and burnings had deforested from 30 to 40 acres for each individual in the tribes.[87] The significant point about the areal extent of the cultivated fields and abandoned croplands, whatever it may

[80] Roland M. Harper estimates that in prehistoric time the mixed shortleaf pine and oak forests of the Southeast were burned over, from all causes, about once every 10 years, and that the longleaf pine forests must have been burned at least 5 years out of 10, but probably not at regular intervals. *Op. cit.*, pp. 33–4. The idea that Indian burning helped to create the nearly pure stands in the longleaf pine forest was expressed as early as the 1840's by Sir Charles Lyell, but probably did not originate with him, for he prefaces his comment with the phrase, "It is said that . . . ." *A Second Visit to North America* (3rd ed.; London, 1855), p. 80.

[81] "The Indian as an Ecological Factor in the Northeastern Forest," *Ecology*, Vol. 3, (1953), p. 339. On reasons for burning, see also Omer C. Stewart, "Burning and Natural Vegetation in the United States," *The Geographical Review*, Vol. XLI (1951), pp. 317–20, and "Fire as the First Great Force Employed by Man," in *Man's Role in Changing the Face of the Earth* (Chicago, 1956), pp. 115–33.

[82] *Op. cit., p.* 185.

[83] *Op. cit., p.* 23.

[84] *Sketches of North Carolina* (New York, 1845), pp. 79, 187, 308.

[85] "The Use and Abuse of Forests by the Virginia Indians," *William and Mary College Quarterly Historical Magazine*, Vol. 19 (1910), pp. 95–6.

[86] *Op. cit.*, pp. 53, 387.

[87] *Op. cit.*, p. 73.

have been, is that the total amount must have been constantly increasing, not merely because of population growth but because of the agricultural system. If one thing is certain about aboriginal farming in the Southeast, it is that the Indians, lacking manure and other fertilizers, were continually clearing new land and abandoning old fields. Most of this land, if left undisturbed for a generation or two, would no doubt have reverted to forest —just as part of the Alabama Black Belt has become reforested in the twentieth century —but the land was *not* left undisturbed. The Indians customarily burned over not only the woodlands but the open tracts as well, which also became favorite hunting grounds; and this burning, to judge from the old reports, was so common and widespread that it is highly improbable that any large part of the cleared and abandoned land had a chance of reverting to forest. On the contrary, it is far more likely that the area of this type of open country was steadily increasing, and since this aboriginal deforestation had been in progress for a long time, for millenia rather than centuries, the upshot is that the open country made by men must have constituted a very considerable part of the old Southeast.[88]

The maximum of cleared land was probably reached at some time before contact was made between the Indians and the Europeans, and thereafter, because the Indians were displaced from many regions and their frequent burning of the vegetation ceased, the area of cleared land diminished and the forested part increased. Maxwell and William Henry Foote both point out that the large open sections in the Shenandoah Valley and on the Piedmont, which were treeless in the 1750's, later became largely covered with forests, so that many of the settlers had to clear away timber from land that formerly had been prairie. Similar increases of forest area have been reported from many other regions. The cessation of Indian burning also meant that the underbrush in the forest had a chance to grow and become dense. The pathless and difficult forest with its tangle of brush that gave its name to the Wilderness Campaign of 1864 in Virginia occupied the same land as did Captain John Smith's "open groves with much good ground betweene without any shrubs." Paradoxical as it may seem, there was undoubtedly much more "forest primeval" in 1850 than in 1650.

The explanations of the origin of the open lands suggested in the historical record can be grouped into two general types. Many of the early writers speak of some of these lands as man-made, while others, like James Adair, refer to the treeless tracts as "natural prairies" or "naturally open lands," their meaning obviously being that the cause was not human activity but some other factor in nature.

Bernard Romans distinguishes between two types of savannas. One type was exemplified by the prairies in northeastern Mississippi, but he expresses no opinion concerning their origin. The other type, which he found mostly in Florida, he describes as "a kind of sink or drain to the higher lands, and their low situation alone prevents the growth of trees in them." I dare say that his explanation is still acceptable. The wet savannas or meadows, covered with standing fresh water for months at a time, perhaps the most common and widespread type of "naturally" open land in the Southeast, are commented upon in a number of the old accounts besides that of Romans, notably by Lederer, Lawson, and Hugh Young.[89]

The "bald prairies" on tops of low knolls and swells in the Alabama Black Belt are explained by Tuomey, Hilgard, Mohr, and Heustis as areas with soil too shallow for tree growth.[90] The question is whether these soils always were shallow, or are "naturally" shallow. Tuomey points out how the soil is "washed away by every shower or rain" from these heights; and it is conceivable that the bald prairies may be the product of acceler-

[88] The plant cover of the Southeast, say in the year 1500 A. D., cannot in its entirety be called a "natural vegetation," because that term, as I think it is most commonly understood, means a vegetation unaffected by man, and man obviously includes not only the white man but the aboriginal Indian. It may be suggested that a critical examination of the meaning and use of the term "natural vegetation" is needed, for as employed on most of the vegetation maps of North America the term is not precise: what these maps represent as "natural" is a vegetation that has been under the influence of human activity for many centuries.

[89] Romans, *op. cit.*, p. 22; Lederer, *op. cit.*, p. 24; Lawson, *op. cit.*, p. 20; Hugh Young, "A Topographical Memoir on East and West Florida," annotated by M. F. Boyd and G. M. Pontan, *The Florida Historical Quarterly*, Vol. 13 (1934), p. 28.

[90] Tuomey, *op. cit.*, p. 136; Hilgard, *op. cit.*, pp. 77, 261; Mohr, *op. cit.*, pp. 48, 104; Heustis, *loc. cit.*

ated sheet erosion set off by deforestation at the hand of man in the distant past.

In 1833 Rush Nutt proposed the theory that the prairies of Alabama, or some of them at any rate, have their origin in blow-downs caused by hurricanes and tornadoes. His argument is that violent winds make openings in the forest canopy, and then grass, sometimes aided by fire, becomes dominant in the open spaces. Whether any prairies actually originated in this fashion cannot be proved by the old narratives, but it can at least be said that the early travelers did observe large openings in the forest made by windfalls, resembling "the swath cut by a reaper through a field of wheat," as C. F. Volney depicts them. Taitt in 1772 and Hodgson in 1820 saw big blow-downs in southern Alabama; Catesby found a number of "glades or openings caused by violent winds" in the Carolinas; and Lusser describes a hurricane path through central Mississippi that was more than two miles wide and extended over so great a distance that "its length was not known."[91]

An old and debated question is whether grasslands are natural products of seasonally dry climates. There is no real dry climate in the Southeast, but there is a real summer drought in some parts, including the Alabama Black Belt.[92] One of the recurring remarks in the narratives from the time of De Soto to the recent period concerns the scarcity of water in the prairies during summer. But it is a scarcity of running streams and springs, and it was understood and explained long ago that the scarcity is caused by a soil or drainage condition rather than by the climate. Hilgard points out: "It is mostly stiff clay which underlies the prairies; hence, a great dearth of water during the dry season." And Gosse says, "The rain-water, owing to the tenacity of the soil, does not sink into the ground but accumulates in the hollows until evaporated by the sun." None of the early writers, to my knowledge, expressed the belief that the summer drought was the *cause* of the Alabama prairies; and it may also be said for the record that neither did any of them suggest that the cause was the heavy clay or the high lime content of the prairie soils.[93]

The cultivated fields and abandoned croplands were man-made, of course, but, to judge from the old reports, it is very probable that many of the open lands described as prairies and savannas were also caused by human activity. It is notable that Bartram, in his descriptions of open country, frequently adds what seems to be an explanatory phrase to his main term for the open land, so that he will say, for example, "level plains, *or old fields*," or "illumined grassy plains, *or native fields*." These phrases can only mean, I think, that in Bartram's opinion the plains or savannas he was talking about were in fact old abandoned croplands. Sometimes, leaving no possible doubt as to his meaning, he says, "An extensive plain *consisting* of old Indian fields." (My italics.) Lederer says that it was "by the industry of the Indians" that much of the Piedmont was "very open and clear of wood." David Taitt and other early observers were struck by the artificial appearance of the Alabama prairies, and found it hard to believe that they were not clearings made by man, for

[91] Rush Nutt, "On the Origin, Extension, and Continuance of Prairies," *The American Journal of Science and Arts,* Vol. 23 (1833), pp. 40–5; C. F. Volney, *A View of the Soil and Climate of the United States* (Philadelphia, 1804), p. 140; Taitt, *op. cit.*, p. 499; Hodgson, *op. cit.*, p. 151; Catesby, *op. cit.*, Vol. 2, p. II; Lusser, *op. cit.*, p. 85.

[92] One can hardly fail to notice the approximate coincidence in shape and position of the Alabama-Mississippi prairie belt, as shown on recent vegetation maps, and similar crescents, representing regions of summer minimum of precipitation, on the maps of E. N. Transeau, "Climatic Centers and Centers of Plant Distribution," *Seventh Report of the Michigan Academy of Science,* Vol. 7 (1905), p. 74, and C. Warren Thornthwaite, "An Approach toward a Rational Classification of Climate," *The Geographical Review,* Vol. XXXVIII (1948), pp. 55–94. The apparent coincidence of the crescents naturally suggests the idea that the summer drought may be the cause of the prairies—although I do not believe these articles actually make that claim. But such an explanation would fail to account for the forested tracts within the crescents and the open prairies outside their limits.

[93] Hilgard, *op. cit.*, p. 76; Gosse, *op. cit.*, pp. 80–1. The early narratives naturally give no accurate information on the calcium content of the prairie soils. Marbut, with reference to the Houston clay in the Black Belt, says, "Because of the high percentage of calcium carbonate in the parent material and its disintegration to clay before the leaching out of the excessive calcium, these soils have not been good forest soils. The natural vegetation on this part of the clay belt, therefore, was grass with scattered trees." *Op. cit.*, p. 42. Whether or not Marbut's explanation is acceptable to foresters and soil scientists of today is for them to say; but it will be noted that Marbut is speaking only of Houston clay, which in 1930, according to Scarseth, represented not more than some 5 percent of the area of the Black Belt soils. *Op. cit.*, p. 9.

they looked "more like the work of Art than of Nature." According to Hilgard, the prairies on the hummocks in the Yazoo basin probably began as Indian clearings.[94] Tuomey unhesitatingly attributes the prairies on the deep soils of the Alabama Black Belt to annual burnings by the Indians, and says that he has observed woods in the way of becoming prairies because of the same practice followed by the white settlers.[95] We learn from Romans that as early as the 1770's the stockmen in the wiregrass country of southern Alabama, Georgia, and Florida were in the habit of frequently firing the woods in order to procure young grass, for the cattle did not like the native wiregrass when it became old and harsh.[96] These fires encouraged not only the growth of the young grass but likewise the growth of the open tracts at the expense of the forest. We can only assume that this process of turning forest into pasture land was begun by the Indians before the coming of the white graziers, but we cannot say so with assurance, for the early stages of the introduction of domesticated animals to the Southeast are still in need of clarification. The eighteenth-century travelers, Lawson, Bartram, and others, make a few comments on Indian horses; Hawkins refers to the dogs, horses, and cattle of the Creek tribes in 1798; and Timberlake, who spent some time among the Cherokees in the 1750's, reports that they had "a numerous breed of horses, also hogs, but neither cows nor sheep."[97] It is not clear, however, how large these herds of Indian livestock actually were, and whether or not they had any appreciable effect on the vegetation cover is difficult to say. Another question to which the historical record does not give a clear answer is how much the grazing and browsing wild animals contributed to the creation and maintenance of the open lands. That they did contribute seems certain.

3. The open lands were distributed throughout the Southeast. Cultivated fields, abandoned croplands, prairies, savannas, and open country under various other labels have been reported not only from the northeastern prairie belt in Mississippi, but from the Yazoo basin and the central and southern parts of that state; not only from the Black Belt in Alabama, but from the Coosa, Tallapoosa, and Chattahoochee river valleys, and from the Alabama counties south of the Black Belt; from the valleys of the folded Appalachians and the Appalachian plateau lands; from both the coastal plains and Piedmont sections of Virginia, North Carolina, South Carolina, and Georgia; and from Florida.

On a vegetation map of the ancient Southeast, if such a map could be constructed from the early records, there would be some areas in dark green color to show the dense and mature forests, other areas in light green to represent the open woodlands, and the map would be liberally flecked with yellow to indicate the scattered tracts of open country. There would be some yellow flecks in the region of the Alabama Black Belt, but no conspicuous concentration of them, and certainly no crescent-shaped area in solid yellow. The Alabama Black Belt, as a distinct and unique vegetation zone, would disappear from this map, not because there was no open country in that region but because open country was common almost everywhere in the Southeast.

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[94] "Report on the Cotton Production in the United States," *Tenth Census of the United States* (Washington, D. C., 1884), Vol. V, p. 40.

[95] *Op. cit.*, p. 137.

[96] *Op. cit.*, p. 16.

[97] Henry Timberlake, *Lieutenant Henry Timberlake's Memoirs 1756–1765*, annotated by Samuel Cole Williams (Johnson City, Tennessee, 1927), p. 72.

# REVIEW ARTICLES

## SOME BASIC MATERIALS ON THE GEOGRAPHY OF ITALY

The publication of Ferdinando Milone's work on the regional economic geography of Italy represents a milestone in Italian geography and in the geographical literature on Italy.[1] It represents a major contribution to the study of Italy, and a new departure as well, for this is not only the most comprehensive survey of Italy to appear since the years preceding World War II, but the first concerted attempt to describe Italy in terms of the sixteen major regions that compose the country.

To paint a canvas of such dimensions, it would have been possible to use only rough strokes, to present a general survey of each region, thus composing an image of that complex phenomenon, modern Italy. Professor Milone used a different approach. Each of his chapters may well be considered a work complete in itself, a picture of that particular region; only statistical tables refer the reader to an over-all image of the country as a whole. This is the greatest strength of this monumental volume, this series of masterfully executed portraits of the several regional economies that compose Italy; this is also its sole, and rather minor, weakness. There is no general statement describing the country as a whole: the author plunges into his first chapter on Piemont, *in medias res* as it were, and there is no conclusion. He who reads the book will, however, put it down with the conviction that here at last is an up-to-date, accurate, authoritative, and superbly written portrait of Italy.

The plan of this work is simple: it consists of sixteen chapters, each describing one of the regions of Italy. Beginning with Piemont, the author proceeds with his analysis of each of the major regions of the North, the Appennine Peninsula, and the islands of Sicily and Sardinia. Subregions are referred to within the text, and the entire technique of presentation is based on the major geographic–traditional regions: Piemont, Lombardy, the Veneto, Liguria, Emilia, Tuscany, Umbria, the Marches, the Roman region of Lazio, the Abruzzi and Molise, Campania, Puglia, Basilicata, Calabria, Sicily, and Sardinia. The author is fully justified, it seems to this reviewer, in following such a rigid scheme of regions based on historical and administrative tradition as well as geographical characteristics. The aim of the work is to present Italy's economy as a function and a result of its regional components. All statistical material, as is evident from the numerous and useful tables scattered throughout the text, is based on the sixteen regions listed above, and these regions are just as meaningful to the average Italian, as the provincial divisions remain matters only of administrative convenience to him, devoid of any significance in a regional–emotional sense. One may well draw a parallel between Italy's regions and France's traditional provinces: there is a definite "regional personality" represented by such names as Brittany or Burgundy, in the same manner as Tuscany or Piemont are fraught with significance in the context of Italian history or Italian politics.

Each of the regional chapters follows the same general pattern: an introductory statement, referring to the "regional personality" and to certain physical characteristics of significance to the economy; a survey of agriculture, in terms of important crops, distinct crop areas, land ownership, land reform and reclamation; a review of industrial development, of mining, and of communications; and a brief description of commerce and, wherever appropriately important, of the tourist trade.

The author does not hesitate to employ vivid and effective descriptive techniques to put across a point of importance. His description of the rolling plateaus, hills, and mountains of the Marche, "resembling a stormy sea" when seen from one of the higher peaks of the region, conveys precisely that image of infinity that the landscape of the Marche, with its successive horizons formed by uplands, is best known for. His characterization of the product best known as Chianti conveys an appreciation of the role that most famous of Italian wines plays in the economy of Tuscany, and a clear-cut appreciation of the quality of the product itself:

> "I believe that it is only right to admit that of all our wines the prize belongs to the Chianti, for its lovely ruby color, its perfume, its sharp taste, its moderate alcohol content which allows one to have just one more glass, and because it is good for the digestion."

Each chapter presents a well-rounded image of the region. Besides the region's general appearance, the nature of its climate and soils, and a sketch of its vegetation, we find a sketch of the historical development of the more important traits of its present-day economy, and a thorough-going discussion of farming, industry, and commerce. The author has a vast and encyclopedic knowledge not only of his country as it appears today, but of Italian history, a subject vital to the understanding of present-day Italian affairs, as well. The references quoted range far and wide across the literature, from seventeenth- and eighteenth-century works on political science and statistics to Carlo Levi's classic of the South, *Christ Stopped at Eboli.*

There is a 127-page bibliography, one of the most valuable parts of the work, since it is a critical and regionally organized statement of the more important sources, past and present, useful for a geographic study of the several regions of Italy. The first of the two indexes is topical, listing alphabetically and for each chapter the places where information on subjects varying from illiteracy to citrus fruit and from tourist trade to port statistics can be obtained. The second index is geographical, listing each place name quoted in the text. The statistical tables are both regional, giving data for a single region, and nation-wide. The cartographic material is unequal; there are a few excellent and useful maps, several in full color, dealing with Italy as a whole and with several of the regions discussed in the text, as well as a number of

[1] Ferdinando Milone. *L'Italia nell'economia delle sue regioni.* Torino: Einaudi, 1955. xiv and 1926 pp. Maps, tables, bibliography, indices. L.12,000.

black-and-white sketch maps, but the maps are scattered within the text, and are obviously of subordinate importance.

Milone's work is likely to remain for some time to come a major statement on the status of Italy in the mid-twentieth century. It is an honest book, not attempting to disguise the cold and often depressing facts of Italian life: one of the sections on the region of Calabria is entitled: "indices of misery"! Yet when one consults this volume, there emerges from it a profound conviction of Italy's progress toward a better life, and a sincere, undisguised affection for the author's homeland. Taken together, these characteristics make Milone's book rewarding reading indeed.

Milone's economic geography of Italy is in many ways a unique contribution to the geographical literature of his country. It is also part of a noteworthy series of books, atlases, guidebooks, and other publications that, taken together, may be said to form a basic reference group on the geography of Italy.

Among private Italian organizations, not under the control of the state, none has contributed as much to the knowledge of Italy as the Touring Club Italiano. For over sixty years this organization, composed of several hundred thousand members and operating as a commercial firm, has been publishing a steady stream of books, atlases, guidebooks, journals, and maps that are a veritable storehouse of Italian geographical lore. The series of guidebooks issued by the "Touring," as it is known far and wide in Italy, is now in its fourth "incarnation," the most recent series having begun publication after World War II. These volumes, generously illustrated with maps on the scale of 1:250,000, and with city maps on a much larger scale, contain a wealth of information of use to the geographer, historical, economic, and physical. Each volume consists of an introductory chapter on the physical geography, history, resources, art, and population of the region, followed by a series of "itineraries" where detailed information on the several areas of the region is provided. Special attention is called in this respect to the earlier series of Touring Club guides, published in the 1920's, for the earlier volumes, especially those on Central and Southern Italy, contain descriptive introductions by some of Italy's greatest geographers, Olinto Marinelli and Giotto Dainelli among them, that are truly minor classics.

The Touring Club is one of the most distinguished European producers of maps. In addition to its well-known *International Atlas*, now in its second edition, the Touring Club published a physical–economic atlas of Italy at the beginning of World War II.[2] This atlas represents Italy on the eve of the war, and although some of its economic maps are now definitely out of date, *e.g.*, the map showing the distribution of natural gas and oil production, it still remains one of the most important reference works for a detailed study of Italy.

Besides its publication of guide books and atlases, and such excellent maps as its series of four maps of Italy on the scale of 1:500,000 (Milano, 1951–53), the Touring Club has now embarked on a new series of works that promises to be as authoritative and as useful as those produced in past years. This series, entitled *Know Italy!*, began publication in 1957 with a volume on the physical geography of Italy,[3] describing climate, volcanism and related phenomena, soils, hydrology and mineral resources. Handsomely illustrated with excellent maps, diagrams, and photographs, this volume augurs well for the latest contribution of the Touring Club Italiano to Italian geography.

According to the findings of the 1951 census, farmers still represent the largest single number of Italians gainfully employed today. The series of publications issued by Italy's most important research center of agricultural studies, the Istituto Nazionale di Economia Agraria, are therefore of signal value to students of Italian geography. Chief among these, and outstanding even in a series noted for its distinction in contributing to the knowledge of Italy's farm economy, is a volume published in 1943 by the outstanding economist and statistician, Professor Ugo Giusti.[4]

Giusti's *Caratteristiche Ambientali*, or *Characteristics of Italy's Agrarian, Social, and Demographic Environment*, is a work indispensable to any study intent upon describing and analyzing Italy's social and economic geography. Professor Milone pays homage to it as a "masterpiece of analysis," and it is true that both its mass of data and the method brought to the understanding of these data are unique in the annals of European geography. Giusti established 178 subdivisions within Italy's pre-1947 frontiers. Each of these is briefly described and precisely located on a key map; each represents a minor regional unit, clear-cut, well recognized by usage, and familiar to the inhabitants of the subdivisions. Such units as the rice-growing Po lowland between the Dora Baltea and the Ticino, the Eastern Riviera (east of Genova), the lowland south of the Po delta, and the coastal "Maremma" near Rome were chosen for the purposes of statistical analysis. The data, referring for the most part to the Italian censuses of 1931 and 1936, are grouped into 136 categories, divided into nine major statistical tables. These tables contain data on land use, in major categories; rank order of crops within each division, and average crop output; size of farm units and animal density per square kilometer; population density and population distribution according to altitude; size and distribution of settlements; sex, occupational, and literacy statistics of the population; types of farm population according to land tenure, including figures on tenancy; birth and death rates and rate of population growth; and immigration and emigration figures for 1882–1901 and 1931–35. Besides absolute data, percentages are also given, and there are twelve maps illustrating the distribution, in major categories, of some of the more important data given in the tables. Truly, Giusti's compendium of Italian life on the eve of World War II will yield important and interesting comparisons that are still meaningful today.

Land ownership and land tenure have been among

[2] Giotto Dainelli. *Atlante Fisico Economico d'Italia.* Milano: Consociazione Turistica Italiana, 1940. xvii pp. 82 double pages of maps, and a descriptive booklet of 147 pp. L.15,000.

[3] *Conosci l'Italia,* Volume I, L'Italia Fisica. Milano: Touring Club Italiano, 1957. 320 pp. Maps, diagrams, bibliography, index. To members of Italian Touring Club only.

[4] Ugo Giusti. *Caratteristiche Ambientali Italiane–Agrarie-Sociali-Demographiche 1815–1942.* Roma: Istituto Nazionale di Economia Agraria, 1943. 344 pp. Maps, tables. L.900.

the more important phenomena in Italian political life since the end of World War II. The land reform measures initiated in 1950 have not yet been brought to completion in the South, and the problem of the *mezzadria*, the farm tenancy problem, that is particularly pressing in Tuscany and in the Marche, is still in the lap of the Italian parliament, where bills on the subject have been debated for the past eight years. Two publications of the Istituto Nazionale di Economia Agraria are most useful for serious studies of these problems, those by Professors Serpieri and Medici.[5]

Professor Medici, who has been one of the most distinguished of Italian scholars in the field of agricultural economics, and played a leading part in the planning and execution of the land reform of the 1950's, deals primarily with the forms of land ownership in Italy. His study is divided into a detailed analysis of the problem, and a series of statistical data, for each of Italy's 91 provinces, these data being subdivided in several ways. First, figures are given for each province for "mountains," "hills," and "lowlands"; second, each major region is subdivided into "agricultural zones," corresponding to well-defined geographic areas. For example, in the province of Ravenna, the hill region consists of only one subdivision, whereas the lowland is subdivided into four segments. (Each of these "agricultural zones" may be identified also in terms of Ugo Giusti's statistical divisions, there being given a key in Giusti's volume for this purpose, permitting further detailed studies to be pursued on the basis of these two volumes!) Medici's data fall into three groups. The first of these distinguishes between self-conducted and leased farms, on the basis of net taxable income. The second distinguishes between "capitalistic" and "non-capitalistic" farms, according to the sources of investment, own income or outside. The third furnishes data on the type of labor employed on Italian farms.

Professor Serpieri's book, *The Social Structure of Italian Agriculture*, deals with the problems of farm labor in Italy, the types of share growing and share cropping, the significance of manual labor, and the important issue of tenancy. Together, Serpieri's, Medici's, and Giusti's works represent a comprehensive and enormously important compendium for further studies on the geography of the Italian countryside.

The use of labor, the degree of employment, and the specter of unemployment and underemployment have been playing a key role in Italy's political and economic affairs since the end of World War II, when the great process of reconstructing the country's shattered economy began. The Central Bureau of Italian Chambers of Commerce, a semi-governmental agency, compiled a series of monographs for each of Italy's 91 provinces;[6] each of these monographs was compiled by the Chamber of Commerce of the province. Each consists of a brief description of the province's physical characteristics, the nature of its agriculture, industry, transport, commerce, and services, the character of its population, the degree of unemployment and the territorial distribution of the unemployed, and a detailed analysis of the present economic problems and future prospects of the province. The data on unemployment, given by months, cover the years 1945–52, as well as 1938, wherever the latter figure was available. This is a massive study, a presentation of individual reports for each of the provinces, but it is a highly significant tool for an analysis of Italian industry and for the Italian economy in general.

Each of the preceding works deals with the whole of Italy, with the exception of the first and last, Professor Milone's great study of economic regions, and the Chamber of Commerce's monumental collection of individual, provincial monographs on unemployment and related problems. To the geographer, these works represent a vast collection of invaluable source material. Whether he is interested in agricultural, transportation, port, manufacturing, or demographic studies, these volumes can provide him with a wealth of data that await geographic techniques of analysis and presentation. In thus using them, the geographer will be able to make a significant contribution to knowledge of that complex and fascinating country, Italy.

GEORGE KISH
*University of Michigan*

[5] Giuseppe Medici. *I Tipi d'Impresa nell'Agricoltura Italiana.* Roma: Istituto Nazionale di Economia Agraria, 1951. 510 pp., tables. L.1,500.

Arrigo Serpieri. *La Struttura Sociale dell'Agricoltura in Italia.* Roma: Istituto Nazionale di Economia Agraria, 1948. 354 pp. L.1,500.

[6] *L'Economia delle Provincie e il Problema della Disoccupazione.* Roma: Unione Italiana delle Camere di Commercio, Industria, e Agricoltura, 1953. 1423 pp. Maps, tables. Price not given.